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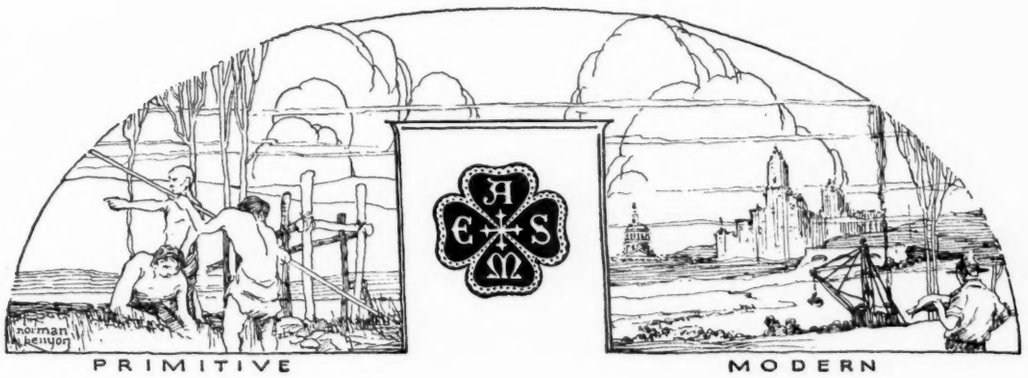

The A. S. M. E.

THE tendency in industry and engineering is toward centralization.

We are beginning to think nationally.

We are beginning to take account of our resources and of our processes of production and fabrication and distribution and to consider how these resources can best be conserved and these processes best conducted for the greatest good of the greatest number; for the realization of that universal well being toward which the race has been groping since man first began his struggle with his environment.

The appraisement of these resources, the systematization of these processes, the organization of our national housekeeping along safe, sane, universally just lines unswayed by the influence of selfish interest upon the one hand or impractical radicalism upon the other is a task for the cool, impersonal, analytical method of the engineer.

His task is becoming more and more definite and concrete; the necessity of unity of thought and the opportunity of unanimity of action are becoming more and more frequent.

And this clarity of thinking, this illuminating of the subject upon all sides, this focusing upon it of the collective wisdom of the profession, this collective compelling action, are possible only through such organization as is manifest in the American Society of Mechanical Engineers, the proceedings of whose annual meeting constitute a large portion of the contents of this issue.

F. R. Low

Field Method For Determining Dissolved Oxygen

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Public Service Electric Co., Newark, N. J.

THE writer, being actively concerned with the determination of dissolved oxygen in water and steam, found the available methods of sampling and analysis either unreliable or unsuited for power-plant use. In this article he describes an improved and simplified method and gives the results obtained in tests at a large power station.

IT WAS recently found necessary to determine the amount of dissolved oxygen in feed water and steam at one of our central stations and to devise a method that would give reliable results when the work is to be carried out by a person who has no special knowledge of chemistry or who is without laboratory facilities. The method must be simple and, so to speak, "foolproof." Going through the literature on the subject, I found that some methods were too complicated for fieldwork and some, although simple, gave questionable results and needed modification to make them serve the purpose.

One of the simplest methods was given a trial, but the results obtained were so abnormal that it had to be abandoned.

Looking into the probable cause or causes of these unreasonably high results, I found that the greatest errors are introduced: (*a*) While taking a sample for analysis, and (*b*) when the manganese chloride and potassium iodide solutions are introduced.

Water, when once freed of air, reabsorbs it rapidly, hence great care should be taken to protect the sample against such possibilities, especially if the air has been wholly or partly removed. A slight decrease in pressure in the container in which the sample is kept or a pressure differing from that of the source of supply will liberate a part of the dissolved air (consequently oxygen) proportional to the change in these pressures.

Samples were at first taken in glass-stoppered bottles which were filled completely with the water to be examined for dissolved oxygen. But when filling the bottle the water must displace an equal volume of air, and air and water will be intimately mixed when the stream of water enters the bottle, thus causing absorbtion of air by the water.

The bottle must therefore be filled without changing the amount of absorbed air, or at least the error should be made as small as possible. This can be done by filling the bottle at the bottom instead of at the top, the water being separated from the air by a water-insoluble medium. A light transformer oil was selected.

All waters should be tested at the standard temperature of 20 deg. C. (68 deg. F.) or as near that as possible, and when a sample of hot water or of steam is taken, it should be cooled to the temperature mentioned.

The cooling of the water or steam is another point that demands attention. In our investigations, results of which are given below, use was made of a glass-coil condenser. As I stated in "Measuring Corrosiveness of Water"[1] a copper coil was used at first but was soon found to be objectionable. A glass coil can be kept clean, thus preventing contamination of the sample. It also allows the operator to watch the sample coming over,

FIG. 1—FIRST STEP IN SAMPLING
Steam flowing gently through the condenser coil and delivery tube. Pail of cracked ice and bottle with oil layer ready. Transformer oil in bottle.

FIG. 2—SECOND STEP IN SAMPLING
Condenser is slowly lowered into bucket filled with cracked ice and water. Note delivery tube gradually filling with condensate.

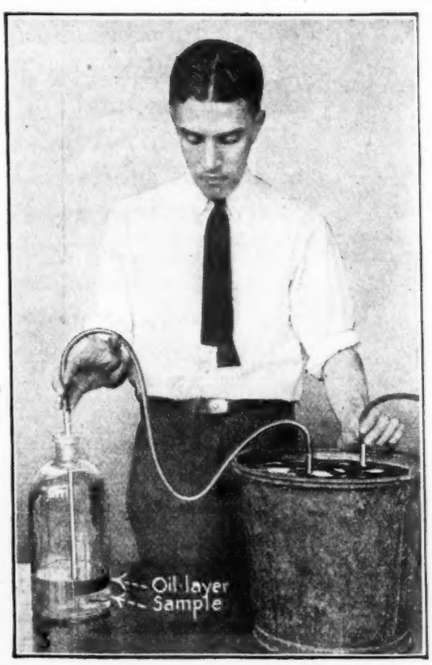


FIG. 3—THIRD STEP IN SAMPLING
After water begins discharging, rubber tube is punched for a moment while delivery tube is plunged under oil, and then quickly released.

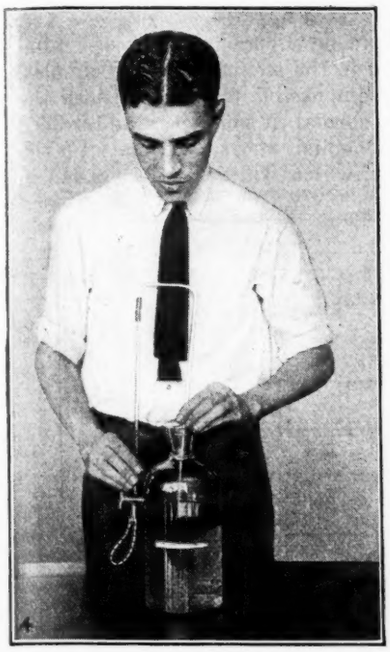


FIG. 4—FOURTH STEP IN SAMPLING
Siphon is submerged with cock open. Cock then closed and collapsed bulb (dotted) attached. Cock opened to siphon sample down to 1,000 c.c. mark (label).

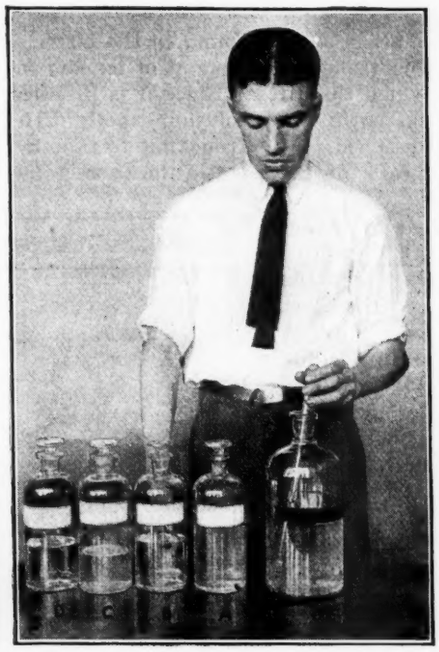


FIG. 5—FIRST STEPS IN ANALYSIS
Solutions introduced below oil layer by pipette in the following order: *A*, manganese chloride; *B*, potassium iodide; *C*, sulphuric acid.

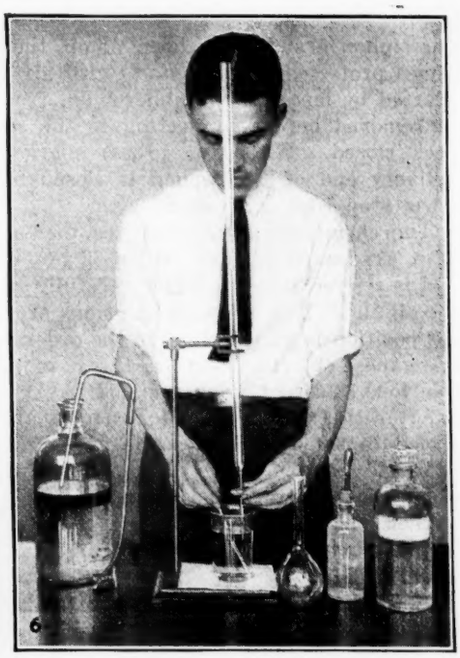


FIG. 6—FINAL STEPS IN ANALYSIS
Siphon 257 c.c. into measuring flask. Place in breaker and titrate with standard sodium thiosulphate using starch indicator. Record amount of thiosulphate used.

sometimes indicating to him the presence of other gases (such as CO_2)[1]. Block tin can be used for a coil, but I prefer glass for the reasons given.

After considerable experimental work the following method was finally adopted and used successfully in several power plants.

Steam samples were taken at a point where the steam enters the turbine, as follows: A short length of $\frac{1}{8}$ in. pipe with valve was tapped into the steam main and connected by rubber pressure tubing to a coil of $\frac{1}{4}$-in. glass tubing about 4 in. in diameter and 10 in. long having 8 turns. To the other end of the coil a piece of rubber tubing was connected, which was provided with a piece of glass tubing about 16 in. long, somewhat taller than the sampling bottle. This glass tubing was slightly drawn out to decrease its diameter at the delivery end.

The steam was turned on very slowly and kept flowing for a few minutes to free the different parts of air. The coil was then gradually dipped into a bucket filled with cracked ice and water. If this is done carefully, the condensation of the steam will take place slowly and the delivery tube will fill itself with water without drawing in air, if it is kept upright. This requires patience and cannot be rushed.

When the entire coil is submerged and a steady stream of water is flowing from the delivery tube, it is time to collect the sample. The rubber tubing is pinched close to the glass tubing and the latter quickly placed in the sampling bottle through the layer of oil and released. If one acts quickly, there is no danger of disconnecting the rubber tubing at the $\frac{1}{8}$ in. pipe. The delivery tube should be filled entirely with condensed steam when placed in the bottle. The temperature should be watched and kept near 20 deg. C.

The sampling bottle should be of white glass, clean and dry before the oil is added to a depth of about 1 to $1\frac{1}{2}$ in. The bottle is marked by a label on the outside to contain 1,000 c.c. After taking the sample, the delivery tube must be withdrawn quickly while pinching the rubber tubing.

Samples of hot water were taken in a similar manner. The most troublesome sample was that taken from the boiler. A $\frac{1}{8}$-in. pipe was connected to one of the "blow-down" valves on the water column, using the same glass coil and delivery tube as in steam sampling. The steam and water were kept flowing freely for some time before the delivery tube was placed under the oil in the sampling bottle.

The rate of flow of the water out of the delivery tube should be uniform, and it should be about the same for all samples. I found 25 to 30 minutes for a liter a proper rate. Whenever samples of water of a higher temperature than 20 deg. C. were taken from a valve, the cooling coil was used.

When water in a tank was sampled, another scheme had to be followed, although the same principle was adhered to of filling the bottle at the bottom under oil. The neck of the sampling bottle (see Fig. 7) was provided with a two-hole rubber stopper, each hole containing a piece of glass tubing, one projecting about one inch above the stopper and ending under the layer of oil, the other projecting about a foot above the stopper and one inch below. By blowing gently in the latter tube the oil in the bottle is forced up so as to fill the lower tube, which is then closed with the finger (same as a pipette). The bottle is then dipped in the tank, the finger being removed when the short piece of tubing is below the surface of the water. The upper tube is kept above the surface and allows the air in the bottle displaced by the oil and water to escape.

The next consideration is the treatment of the sample with the chemical solutions and the titration for dissolved oxygen.

The method is as follows: When a sample collected is larger than 1,000 c.c. the excess is removed by means of a glass siphon with a stop cock. When placed in the bottle through the layer of oil, the stop cock is open. As

[1]See *Power*, May 23, 1922, page 829.

the siphon first takes a layer of oil, the sample is at all times protected from contact with air. The siphon is started by means of a rubber bulb, from which the air is removed before connecting to the siphon with stop cock closed. When the proper mark is reached, the delivery end of the siphon is closed by means of the glass stop cock, and withdrawn.

The chemicals in solution are then added by means of a graduated pipette, which is not entirely emptied and is stirred into the water carefully without breaking the oil film. The following solutions are used (the exact composition is given later) in the order named: 8 c.c. of manganese-chloride solution, 12 c.c. of potassium-iodide solution, 12 c.c. of sulphuric acid.

After the sulphuric acid is added, another siphon is placed in the sampling bottle and 257 c.c. withdrawn (250 c.c. of the water plus 7 c.c. for the solutions added) into a graduated volumetric flask. This sample is then placed in a beaker and titrated with fiftieth-normal sodium thiosulphate, using starch as an indicator.[2]

In titrating (see Fig. 6) the standard thiosulphate solution is run into the beaker drop by drop from the burette while stirring. When the yellow-brown color produced by the iodine is nearly removed, the solution is again colored by adding a few drops of starch solution and the titration continued until the blue color caused by the starch and iodine just disappears. It is essential that the same amount of starch be used for all titrations to get uniform results. At least two titrations should be made.

A record is made of the number of cubic centimeters

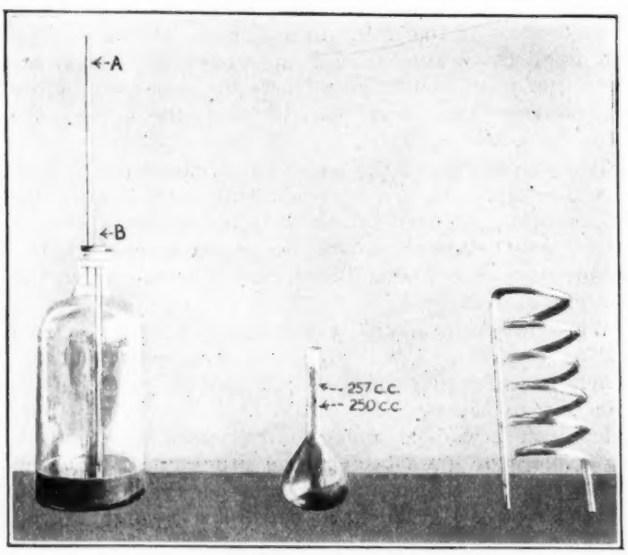


FIG. 7—SAMPLING APPARATUS

On the right is the glass condenser coil. In the center is the flask used for measuring the sample for filtration. The bottle at the left is arranged to sample the water in an open tank. Blow on *A* until oil overflows at *B*. Close *B* with finger and submerge in tank with top of *B* below surface of water. Remove finger to admit sample.

of the thiosulphate used up in the titration. This, multiplied by the factor 0.448, gives the cubic centimeters of oxygen per liter in the sample,[3] assuming the thiosulphate to be exactly fiftieth normal.

A blank should be run to determine the amount of dissolved oxygen in the test solutions. The oxygen found in the blank should be subtracted from the total amount of oxygen found in the steam or water samples.

Since it is practically impossible to make or keep the solution exactly fiftieth normal, it must be standardized from time to time by a chemist who should mark on the bottle the correct factor, which will vary from 0.448 in

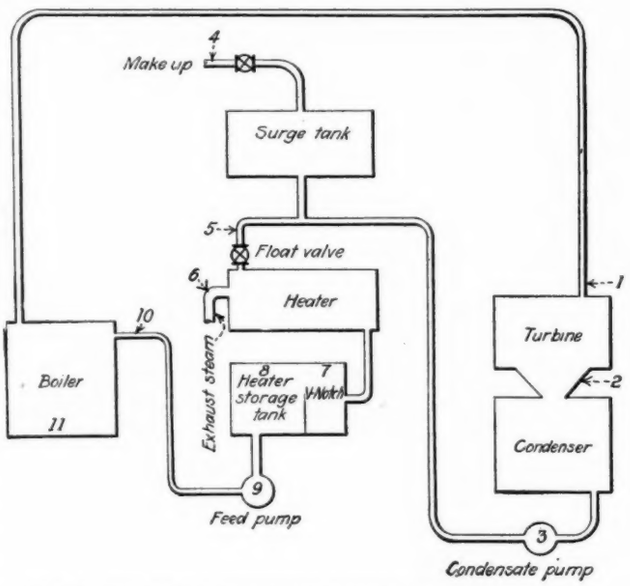


FIG. 8—DIAGRAM SHOWING POINTS WHERE SAMPLES WERE TAKEN

the same proportion as the strength of the solution varies from fiftieth normal.

The principle of the test is so well known that little discussion is necessary. It is based upon the liberation of iodine from potassium iodide in proportion to the amount of dissolved oxygen present, the liberated iodine being determined by sodium thiosulphate using starch as an indicator.

The presence of nitrites, nitrates and organic substances in the water interferes with this test, but they usually will not be found unless there is a leak in the condenser or the water is contaminated through some other source.

Attention should here be called to an inaccurate method often followed in which the sample water is poured into an open vessel and the chemicals added. The originator of this method warns not to shake the mixture, but to let it stand undisturbed for about two minutes after the successive additions of the test solutions in order to prevent dissolving air, which by the way cannot be prevented in an open vessel. Diffusion is likely to occur, but absorption of oxygen surely, thus introducing a considerable error after each addition of the manganese chloride and potassium iodide solutions.

The solutions required are made up as follows:

a. Manganese chloride solution: Dissolve 40 grams of $MnCl_2$ in 100 c.c. of boiled, freshly distilled water.

b. Potassium iodide solution: Dissolve 70 grams of KOH (stick form) and 15 grams KI pure crystals free from iodates in 100 c.c. of freshly distilled water.

[2] As the "fiftieth-normal" solution must, in any case, be made up and standardized by a skilled chemist, no attempt will be made here to explain the meaning of the term.

[3] The factor 0.448 is obtained as follows: One cubic centimeter of a normal solution of the thiosulphate will neutralize the iodine released by 0.008 gram of oxygen, so one cubic centimeter of a fiftieth-normal solution will determine $0.008 \div 50 = 0.00016$ gram. Under standard conditions 1,000 c.c. of oxygen equals 1.4289 grams, so 0.00016 gram will be $0.00016 \times 1{,}000 \div 1.4289 = 0.11196$ c.c. Since only one-quarter of a liter is titrated, the oxygen per liter will be $0.11196 \times 4 = 0.448$ c.c. for each cubic centimeter of the thiosulphate used in the titration.

c. Sulphuric acid: Add about 50 c.c. of the concentrated acid to 50 c.c. of freshly distilled water.

d. Starch solution: Make from arrowroot starch, rubbing a few grams of the starch into a paste with cold water to which boiling water under constant stirring is added until a translucent solution is obtained and filtered. One or two drops of chloroform added will keep the solution for some time.

e. Sodium thiosulphate: One liter of fiftieth-normal strength to be standardized so that its factor is accurately known. This solution should be checked from time to time and kept properly in an amber-colored bottle.

All chemicals to be used for these solutions should be of the highest purity; tested reagents are the best. Since each titration requires respectively two and three cubic centimeters of the test solutions, only small amounts of them should be made at a time. One hundred cubic centimeters will be sufficient for at least 25 determinations.

The following apparatus is required: Burette stand with white base; 25-c.c. burette graduated in $\frac{1}{10}$-c.c.; 400-c.c. beaker; glass stirring rod with policeman; graduated 250-c.c. glass-stoppered volumetric flask with extra mark for the additional 7 c.c.; sampling bottle; glass coil.

The results of a test made at one power plant to determine the oxygen content of steam and water at various points in the cycle of operation are given in Tables I, II, III and IV.

The locations of the various stations are indicated in Fig. 8.

In test B, when taking steam samples at the low-pressure end of turbine No. 3, about 10.5 c.c. of undissolved gases were collected in a pipette. This consisted mainly of CO_2. Only a qualitative test was made. The formation of this gas is due to the decomposition of sodium carbonate used for feed-water treatment. This gas is highly objectionable as it forms carbonic acid, which is corrosive and becomes more so in the presence of free oxygen.

Steam delivered to turbine No. 3 was collected and examined qualitatively for sodium carbonate, which was found to be present in large amount. The alkalinity of the condensed steam was rather high. This indicates that sodium carbonate is carried by the steam from the boiler and deposited in the turbine as the steam collected at the low-pressure end is practically free from sodium carbonate.

In test C the amount of sodium carbonate used for water treatment had been reduced since test B. The results of test C indicate that the volume of CO_2 previously found was due to sodium carbonate used in the feed water, as but little makeup water was required.

Test D was made after certain changes had been made in the system to reduce the amount of air admitted to the feed-water heater with the exhaust steam.

It was not clear, at first, why the water in the heater before and after the V-notch in test A showed an oxygen content of 2.05 and 2.06 c.c. respectively, while the surge tank indicated only 0.82 c.c. No makeup water was used at the time of the test, but condensate only.

A few changes were made and the test repeated (test B). The same conditions were found even when the atmospheric valve was closed: Surge tank, 0.39 c.c.; heater before V-notch, 1.01 c.c.; heater after V-notch, 1.06 c.c.

The next step was to investigate the condition of the exhaust steam entering the heater. With the drain open to the atmosphere (test B), 2.73 c.c. of oxygen was found, while the V-notch readings were 0.83 and 1.03 c.c. respectively. The surge tank showed 0.43 c.c. A slight vacuum was noticed at intervals in the exhaust-steam line. When the drain was closed to the atmosphere by means of a trap, the conditions became normal.

TABLE I—DATA OBTAINED IN TEST A

Station	Sample From	Temp., Deg. F.	C.C. Oxygen per Liter
	Unit No. 2		
1	Steam line to turbine	...	0.345
3	Condensate pump	80	0.59
4	Make-up tank	60	5.18
5	Surge tank	55	0.82
7	Heater before V-notch	200	2.05
8	Heater after V-notch	200	2.06
9	Feed pump	195	1.56
10	Feed line between pump and boilers	195	0.63
11	Boiler	...	0.325
	No steam sample could be collected at the low-pressure end of this unit.		
	Unit No. 3		
1	Steam line to turbine	...	Trace
3	Condensate pump	80	0.485
	Steam at low pressure end of turbine	...	Trace

TABLE II—DATA OBTAINED IN TEST B

Station	Sample From	C.C. Oxygen per Liter
1	Steam line to turbine No. 3	2.82
2	Steam at low-pressure end of turbine No. 3	1.39
	Note: Samples 1 and 2 taken simultaneously.	
3	Condensate pump No. 2	0.92
3a	Condensate pump No. 3	1.04
4	Makeup water	5.32
5	Surge tank (atmospheric valve open)	1.52
7	Heater before V-notch	1.30
8	Heater after V-notch	1.58
	Note: Samples 5, 7 and 8 taken simultaneously.	
5a	Surge tank (atmospheric valve closed)	0.39
7a	Heater before V-notch	1.01
8a	Heater after V-notch	1.06
	Note: Samples 5a, 7a, and 8a taken simultaneously.	
3aa	Condensate pump No. 3	0.36
5b	Surge tank (atmospheric valve closed)	0.35
7b	Heater before V-notch	0.72
8b	Heater after V-notch	0.89
	(Pressure in heater about 4 in. of mercury)	
	Note: Samples 3a, 3aa, 5b, 7b and 8b taken simultaneously.	
3b	Condensate pump No. 2	0.315
6	Exhaust steam to heater (drain open to atmosphere)	2.73
5c	Surge tank (atmospheric valve open)	0.43
7c	Heater before V-notch	0.83
8c	Heater after V-notch	1.03
	(Pressure in heater about 4 in. of mercury)	
	Note: Samples 3b, 6, 5c, 7c and 8c taken simultaneously.	
6a	Exhaust steam to heater (drain closed to atmosphere)	0.92
	(Note: A partial vacuum was noticed in the exhaust steam line from time to time.)	
11	Boiler No. 3 water column	0.38
9	Feed pump	0.54
10	Feed line between pump and boiler No. 3	0.63
	(Note: Samples 9 and 10 were taken simultaneously.)	

TABLE III—DATA OBTAINED IN TEST C

Station	Sample From	C.C. CO_2 per Liter
1	Steam line to turbine No. 3	1.80
2	Steam at low-pressure end turbine No. 3	None
3	Condensate pump No. 3	None
	(Note: Samples collected simultaneously.)	
1a	Steam line to turbine No. 3	1.57
2a	Steam at low-pressure end turbine No. 3	Trace
3a	Condensate pump No. 3	None
	(Note: Samples collected simultaneously.)	
1b	Steam line to turbine No. 3	1.37
2b	Steam at low-pressure end turbine No. 3	None
3b	Condensate pump No. 3	None
	(Note: Samples collected simultaneously.)	
4	Makeup water	
	First sample	1.32
	Second sample	1.78
	Third sample	(lost during analysis)
	Fourth sample	1.27

TABLE IV—DATA OBTAINED IN TEST D

Station	Sample From	C.C. Oxygen per Liter
1	Steam to turbine No. 3	1.26
2	Steam at low-pressure end turbine No. 3	0.58
3	Condensate pump No. 3 (slight leak)	1.65
3a	Condensate pump No. 2	1.20
	(Note: Samples 1, 2, 3 and 3a taken simultaneously.)	
3b	Condensate pump No. 2	1.33
4	Makeup water	4.46
5	Surge tank	1.19
6	Exhaust steam to heater	1.81
7	Heater before V-notch	0.87
8	Heater after V-notch	0.84
	(Note: Samples 3b, 4, 5, 6, 7 and 8 taken simultaneously.)	
9	Feed water at pump	0.49
10	Feed water line between pump and boiler	0.49
	Note: Samples 9 and 10 taken simultaneously.)	
11	Boiler No. 3 water column	0.145

Condenser Specifications and Bids for Detroit Municipal Plant

In the November 27th issue details were given of the turbine specifications, and a tabulation of the various bids. Similar data on the condensing equipment are presented herewith. It should be stated that the condenser bids, received last January have been reject d and for a time the entire project was held up pending the results of the popular vote on raising the bonding limits of the city. At the recent election the bonding issue was carried, so it is probable that new bids will be called for on slightly modified requirements. The initial tabulation of condenser bids is presented here, as it illustrates the methods employed and contains a wealth of valuable information.

THESE specifications and the preceding "General Conditions" and "General Specifications"[1] are intended to provide for all the labor and materials necessary to furnish the condenser units hereinafter specified.

Extent of Work—The following work is not to be included as a part of that covered by these specifications:

(1) Foundations and supporting steelwork.

(2) All motors without pulleys or couplings delivered to contractor f.o.b. cars Detroit or at his receiving point, as he may designate.

(3) All piping except that hereinafter specified.

(4) All starters, controllers and electric wiring connections.

(5) Atmosphere relief valves.

(6) Main condenser tubes and ferrules delivered f.o.b. cars at plant.

All other work, including all labor, materials, equipment and accessories further mentioned or necessary for constructing the condenser units hereinafter specified, shall be done as a part of the work covered by these specifications.

Number Required—Three or four units shall be furnished at the option of the commission.

Description of Unit—Each unit shall consist of a surface condenser, circulating pumps, condensate pumps, air-removal equipment, interconnecting piping and connection to turbine exhaust.

Capacity—Each unit shall be capable of reducing the absolute back pressure at the turbine exhaust to 1 in. of mercury when the turbine is exhausting 210,000 lb. of steam per hour and the temperature of the circulating water is 55 deg. F.

Condenser—The condenser shall be two-pass, containing not less than 32,000 sq.ft. of cooling surface. It shall be rigidly attached by means of a distance piece to the turbine exhaust and supported on springs.

The cooling surface shall consist of 1 in. outside diameter tubes of such copper alloy as the commission may decide to purchase. Tube plates shall be Muntz metal at least $1\frac{3}{8}$ in. thick and of such diameter that the tubes do not occupy more than 33 per cent of the area circumscribed by the inner edge of the water-boxes. Both tube sheets of each condenser shall be drilled and tapped for packing and ferrules.

Circulating Pumps—Two centrifugal double-suction volute-type circulating pumps, each mounted on a common sub-base with and direct-connected to a variable-speed electric motor, shall be furnished with each condenser. The two pumps shall be capable of simultaneously discharging through their condenser 20,000 U. S. gal. per min. each when the water level in the intake conduit is 2 ft. lower than that in the discharge conduit.

The impellers shall be of Government bronze with all surfaces machined or hand filed. Impeller inlets shall be provided with renewable bronze labyrinth rings. Shafts shall be protected from the water by removable bronze sleeves. Bearings shall be ring oiling, horizontally split, renewable and independent of stuffing boxes.

Condensate Pumps—Two centrifugal volute-type condensate pumps mounted on a common sub-base with and direct-connected to a constant-speed electric motor shall be furnished with each condenser. Each pump shall be capable of discharging not less than 600 gal. per min. against a head of 150 ft. not including the vacuum on the pump suction.

The character of construction shall be equal to that specified for circulating pumps.

Air-Removal Equipment—Air-removal equipment shall be of the steam-jet type. There shall be two equipments complete with inter and after condenser for each condenser unit. Each equipment shall be capable of withdrawing 19 cu.ft. of dry free air at 70 deg. F. and $28\frac{1}{2}$ in. vacuum and 13 cu.ft. at 29 in. vacuum referred to a 30-in. barometer.

Steam for jets will vary from 300 to 325 lb. per sq.in. gage with 200 deg. of superheat. Any pressure regulator required to reduce this pressure to a point suitable for the jets shall be provided, one for each equipment.

Alternate proposals on air-removal equipment of the hydraulic and rotative dry vacuum type will be considered at the option of the bidders.

Piping—The following piping connections shall be furnished and installed with each condenser:

(1) Suction lines with bell-shaped inlets from intake conduit to circulating pumps.

(2) Discharge connections with hydraulically operated gate valves from circulating pumps to condenser.

(3) Overflow pipe with bell-shaped outlet from condenser to discharge conduit.

(4) Suction connections with gate valves from condenser hotwells to condensate pumps.

(5) Air connections with valves from condenser to each air-removal equipment.

Turbine Exhaust Connections—Each condenser shall be provided with a cast-iron filler piece complete with bolts and gaskets and connected to turbine exhaust.

Accessories—Each condenser unit shall be provided with gage, thermometers, mercury column, hinged doors to permit cleaning, hotwell gage glasses, supporting springs and hydraulic jacks, and all bolts and connec-

[1] These specifications were accompanied by a set of bidding plans showing the general arrangement of the plant and were preceded by a general specification that described the plant contemplated and the conditions under which its equipment was to be built and installed.

SCHEDULE OF CONDENSER BIDS MORRELL STREET PLANT, PUBLIC LIGHTING COMMISSION, CITY OF DETROIT

I	Bidder		Allis-Chalmers Co.		Elliott Co.		Elliott Co.		Ingersoll-Rand		Westinghouse Elec. & Mfg. Co.		C. H. Wheeler Mfg. Co.		Wheeler Cond. & Eng. Co.		Worthington Pump & Machine Corp.	
II	Address		Milwaukee, Wis.		Pittsburgh, Pa.		Pittsburgh, Pa.		New York		East Pittsburgh, Pa.		Philadelphia, Pa.		Carteret, N. J.		Harrison, N. J.	
III	Price, 3 units		$214,900		$187,583		$184,583		$176,500		$283,800		$206,550		$241,800		$235,500	
IV	Price, 4 units		$283,200		$250,000		$246,000		$235,333		$378,400		$275,400		$320,000		$314,000	
				Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance		Per Cent Tolerance
1.	Delivery time, weeks		50	—5	35, 44, 48, 52	+5	35, 44, 48, 52	+5	52	4 wk.	3 units–50 4 units–52	.....	20, 24, 28, 32	2 wk.	20 to 32	0	1st. 6 mos. and 3 wk. intervals	..
2.	Erection time, weeks		20	—5	9 wk. after last delivery	+5	9 wk. after last delivery	+5	32	4 wk.	3 units–36 4 units–38	.....	6 wk. per unit	10 days transit	10	0	45 days per unit after arrival	..
3.	Net wt. without tubes, lb.		196,000	±5	222,000	±5	222,000	±5	140,000	5	148,000	.....	174,000	7	169,000	5	178,000	5
4.	Net wt. circ. pump, lb.		13,000	±5	12,000	±5	12,000	±5	21,000	5	11,125	.....	16,500	7	17,500	5	14,750	5
5.	Net wt. cond. pump, lb.		3,000	±5	1,000	±5	1,000	±5	1,350	5	2,250	.....	2,000	7	1,500	5	3,000	5
6.	Tube surface, sq.ft.		32,000	0	32,000	0	32,000	...	16,000	0.5	32,000	.....	32,000	1	32,000	0	32,000	.
7.	Circ. water, g.p.m.	1 pump	26,500	+5	20,000	±3	20,000	±3	25,000	3	26,000	.....	25,000	5	32,000	0	28,000	.
		2 pumps	40,000	+5	40,000	±3	40,000	±3	40,000	3	40,000	.....	40,000	5	40,000	0	40,000	..
8.	Abs. back press., in. of Hg., 2 pumps, circ. water at 55 deg. F., steam condensed	Lb. per Hr.											Not to exceed	Expected				
		250,000	1.15	0	1.05	0.4	1.05	0.4	1.2	3% of load	1.14	.....	1.05	0.95 in.	1.02	0	1.01	..
		210,000	1.0	0	0.9	0.4	0.9	0.4	1.0	3% of load	0.99	.....	0.95	0.85	1.0	0	1.0	..
		160,000	0.85	0	.....	...	.....	...	0.85	3% of load	0.8	.....	0.8	0.7	1.0	0	1.0	..
		120,000	0.8	0	.....	...	.....	...	0.8	3% of load	0.8	.....	0.7	0.6	1.0	0	1.0	..
9.	Abs. back press., in. of Hg. one pump. circ. water at 55 deg. F.	Lb. per Hr.																
		210,000	1.2	0	*1.25	0.4	*1.25	0.4	1.35	3% of load	1.18	.....	1.15	1.05	1.0	0	1.01	..
		160,000	1.0	0	*1.0	0.4	*1.0	0.4	1.05	3% of load	0.97	.....	0.95	0.85	1.0	0	1.0	..
		120,000	0.85	0	.....	....	.....	....	0.9	3% of load	0.8	.....	0.8	0.7	1.0	0	1.0	..
10.	Loss of head through condenser, ft.	1 pump	8	±10	5	5	5	5	3.4	7	9	.....	8	....	7	5	6.25	..
		2 pumps	15	±10	14	5	14	5	8.5	7	13	.....	14	....	11	5	12.25	..
11.	Circ. pump characteristics two pumps operating	Horsepower	158	+5	118	±5	118	±5	103.5	3	167	.....	130	....	132	2	126	..
		Speed, r.p.m.	350	0	390	±3	390	±3	246	.....	490	.....	300	....	290	2	360	..
		Head, ft.	25	0	18	±5	18	±5	16	.....	25	.....	20	....	20	2	20	..
		Efficiency, per cent	80	0	77	—0+3	77	—0+3	78	.....	75.5	.....	78	1	76	0	80	..
12.	Condensate pump characteristics	Horsepower	57	+5	46	±5	46	±5	55	3	92	.....	51.5	....	56	2	50	..
		Speed, r.p.m.	1,150	0	1,800	±3	1,800	±3	170	.....	1,750	.....	1,750	....	1,750	2	1,200	..
		Head, ft.	180	0	150 external	±5	150 external	±5	150 disch.	.....	185	.....	180	....	185	2	183	..
		Efficiency, per cent	50	0	60	—0+3	60	—0+3	52	.....	31	.....	53	2	50	0	55	..
13.	Steam req'd., lb. per hr., each, air removal equipment	1st stage	600	±3	650	±5	†650	±5	240	3	380	.....	300	5	390	2	†210	..
		2nd stage	700	±3	190	±5	†130	±5	600	.....	1,030	.....	625	5	390	2	†490	..
14.	Characteristics Hydraulic and R. D. V. pumps	Horsepower	.....	....	.....	...	.....	...	.....	.....	64	.....	.....	....	.....	..	52.5	..
		Speed, r.p.m.	.....	....	.....	...	.....	...	.....	.....	700	.....	.....	....	.....	..	1,800	..
		Horsepower	.....	....	.....	...	.....	...	10	3	.....	.....	.....	....	.....	..	20	..
		Speed, r.p.m.	.....	....	.....	...	.....	...	275	.....	.....	.....	.....	....	.....	..	120	..
15.	Temp. diff. deg. F., steam entering cond. and condensate leaving hot well. Circ. water, 55 deg. F.	Lb. per Hr.											Not to exceed	Expected				
		210,000	8	±10	2	0	2	...	2.5	.....	2.0	.....	at 1 in. vac. 5	4	2	0	3	..
		160,000	10	±10	2	0	2	...	2.5	.....	2.4	.....	at 1.5 in. vac. 4	3	3	0	4	..
		120,000	12	±10	2	0	2	...	3	.....	2.8	.....	at 2 in. vac. 3	2	5	0	.....	..
16.	Pressure drop, in. of Hg., Exh. steam inlet to air offtake cond. 210,000 lb. per hr., b. press. 1 in. abs.		0.2	0	0.1	0	0.1	...	0.1	.....	0.15	.....	Not given	....	0.05	0	0.2	..
Number of tubes			6,115	....	6,150	...	6,150	...	3,500, ⅞ in. dia.	.....	6,088	.....	6,112	....	.....	..	6,820 18 ft. 3 in.	..

* Taken from curve. † Common inter and after cooler for both equipments.

tions necessary for anchoring and attaching the equipment to the foundations and supporting steelwork.

One set of wrenches and such special tools as are required by peculiarities of design shall be provided.

Shop Tests—Such one of the circulating pumps as the engineer may designate shall be tested in the shops for performance. If this pump fails to meet the guarantees, such of the remaining pumps shall be tested as the engineer may require.

The condensate pumps shall be similarly tested.

Delivery and Erection—The equipment comprising each condenser unit with all auxiliaries and accessories shall be delivered and completely erected.

PROPOSAL FORM TO BE COPIED BY BIDDER

(Date) .....192...

(Name of Bidder) .....

Original or Duplicate Proposal for Condenser Units to the Public Lighting Commission of the City of Detroit

I. The undersigned proposes and agrees to contract with the Public Lighting Commission of the City of Detroit in the form of contract accompanying the specifications, to furnish all the labor, materials and equipment, and perform all the work called for by the specifications and drawings which they mention, prepared by Smith, Hinchman & Grylls, 800 Marquette Building, Detroit, Mich., entitled "Specifications for Machinery and Equipment" for Morrell Street Plant of the Public Lighting Commission of the City of Detroit, Section F, "Specifications for Condenser Units," and agrees to accept as payment therefor the sum of ..... $..... for three units; ..... $..... for four units.

II. The undersigned further proposes that the execution of his work and the character and performance of the completed work will conform to the following, and guarantees that the deviation therefrom will not exceed the tolerances which he has stated:

	Per Cent Tolerance
(1) Time within which shipment will be made after entering into contract, weeks	____ ____
(2) Time within which erection will be completed after shipment, weeks..	____ ____
(3) Net weight of condenser without tubes and exhaust connection, lb..	____ ____
(4) Net weight of circulating pump without sub-base, lb.....	____ ____
(5) Net weight of condensate pump without sub-base, lb.....	____ ____
(6) Tube surface per condenser, sq.ft....	____ ____
(7) Circulating water, gal. per min.:	
1 circulating pump operating...	____ ____
2 circulating pumps operating..	____ ____
(8) Absolute back pressure (inches of mercury) when operating both circulating pumps with 55 deg. F. water and condensing the following amounts of steam:	
250,000 lb. per hour.....	____ ____
210,000 lb. per hour.....	____ ____
160,000 lb. per hour.....	____ ____
120,000 lb. per hour.....	____ ____
(Submit curves based on 55, 65, and 75 deg. F. temperature of circulating water)	
(9) Same as (8) but operating one circulating pump:	
210,000 lb. per hour.....	____ ____
160,000 lb. per hour.....	____ ____
120,000 lb. per hour.....	____ ____
(Submit curves as for 8)	
(10) Loss of head through condenser, ft.:	
1 circulating pump running.....	____ ____
2 circulating pumps running....	____ ____
(11) Horsepower, speed, head and efficiency of circulating pumps when two are running:	
Horsepower	____ ____
Speed, r.p.m.	____ ____
Head, ft.	____ ____
Efficiency, per cent	____ ____
(Submit characteristic curves)	
(12) Horsepower, speed, head and efficiency of condensate pump:	
Horsepower	____ ____
Speed, r.p.m.	____ ____
Heat, ft.	____ ____
Efficiency, per cent	____ ____
(Submit characteristic curves)	
(13) Steam required for each air removal equipment, lb. per hr.:	
For first stage	____ ____
For second stage	____ ____
(14) Speed and horsepower required to operate each hydraulic and R.D.V. pump:	
Hydraulic Pump	
Horsepower	____ ____
Speed, r.p.m.	____ ____
R.D.V. Pump	
Horsepower	____ ____
Speed, r.p.m.	____ ____
(15) Difference (deg. F.) between temperature of exhaust steam entering condenser and temperature of condensate leaving hotwell with 55 deg. F. circulating water when condensing the following amounts of steam:	
210,000 lb. per hour.....	____ ____
160,000 lb. per hour.....	____ ____
120,000 lb. per hour.....	____ ____
(Submit curves based on 55, 65 and 75 deg. circulating water)	
(16) Pressure drop from exhaust steam inlet to air offtake when condensing 210,000 lb. per hour of steam with an absolute back pressure of 1 in., inches of mercury.....	____ ____

(17) List of spare parts and number which bidder recommends be carried and price each at which he will furnish and deliver them with the condenser units:

Name of Part Number Price Each

III. If this proposal shall be accepted by the Public Lighting Commission and the undersigned shall fail to contract as aforesaid and to furnish the required bonds within 10 days, not including Sundays, from date of serving written notice from the engineer that the contract is ready for signature, then the undersigned shall be considered to have abandoned the contract, and the certified check accompanying this proposal, for the sum required by the notice to bidders, shall become the property of the Public Lighting Commission. If the undersigned enters into the contract in accordance with this proposal, or if his proposal is rejected, then the accompanying check shall be returned to the undersigned.

IV. Signed and sealed this.....day of..... 192..

(Signature of bidder with business address)

There must be enough ammonia in the system to insure a solid stream of liquid going through the expansion valve, and there should be enough vapor evaporated from the liquid to make the evaporating coils take up heat equal to the capacity of the plant. In addition there must be enough surplus to allow for loss by leakage and for possible pocketing of the liquid somewhere in the system. It is evident that, in predetermining the ammonia necessary for the system, one of the items needed is the volume of the evaporating coils.

Analyzes Opportunities and Shortcomings of the Engineer

Retiring President of the Mechanical Engineers Makes Strong Appeal for Greater Participation of Professional Engineers in Matters of Finance, Business and Public Affairs

THE presidential address by John Lyle Harrington, delivered at the opening session of the A.S.M.E. annual meeting, was a searching analysis of the engineer's status in industry, in business and in public affairs, accompanied with suggestions for overcoming some of the present shortcomings. It is only within recent years, he pointed out, that engineers have emerged from the artisan class and something of the old impression still remains in the public mind in spite of the scholastic training now required. It is true that the World War brought home to the public in a spectacular manner the fact that warfare rests entirely on industry and both on engineering—a realization that materially raised the profession in public esteem; yet in spite of this, the engineer has not maintained the position in business, financial and public affairs to which he is entitled. The engineer has created modern industry and has enabled our industries to compete in the markets of the world with handicraft nations possessing lower standards of living, but he has been so intent upon devising means of production that he has failed to establish his position as to the other leading factors in our social life. In fact, he is too prone to assume the rôle of an employee and devote himself to the interests of his individual employer. He is usually looked upon as a specialist and therefore has not been accorded full confidence as a business man by financiers. Moreover, business men have little faith in him in business matters, but his scientific methods applied to those problems that are too complicated for the business man's solution or judgment should result in better understanding of the fluctuations in business and assist in producing remedies that would greatly alleviate fluctuations that are responsible for unemployment.

The country is still governed by politicians and lawyers. The latter reason by way of precedent and have their eyes upon the past; hence we progress slowly. In this field the engineer with his constructive, creative and scientific mind is needed, but in order that he may render such service his preparation should be broadened so that he may receive the same public confidence in his human qualities and in his understanding of public matters as is now placed in his honesty of purpose and his scientific knowledge.

Citing the case of the railroads and water transportation systems, Mr. Harrington showed how the engineer has replaced speculative financing with most beneficial results. Another important problem awaiting solution and one in which the engineer can bring to bear his training is that of distribution. Present marketing methods are unscientific with the result that many industries are out of balance, and it is here that a sound scientific judgment based upon knowledge of all facts would prevent great diversity of reward among those engaged in fundamental industries. While engineers consider themselves competent to organize industry, they have failed, in the opinion of the speaker, to organize effectively their own profession. There are too many groups of narrow and specialized interests as contrasted with certain of the other professions, such as the law, in which the Bar Association exerts the weight of the profession in public affairs.

THE engineer has created modern industry, has been responsible for a production of goods that in this country is substantially sufficient, if other factors were in accord, to establish the universal comfort and well-being that the race has sought since the beginning. But the engineer has been so intent upon devising means for production, upon improving the quality of product and of managing the men and tools of production to secure the maximum results that he has failed to develop his ability and to establish his position in the other leading factors of life, to which he is entitled by virtue of his part in production and the resulting welfare.

One of the greatest causes of unrest on the part of the worker lies in his lack of understanding of the value of the other factors necessary between the basic raw materials and the consumer of goods. The engineer in his present position of impartial technician, ought to be the agency to determine what should be the difference between the cost of production and the cost to the consumer, of exposing the truth and righting the errors and abuses now existing, then of showing labor what is its just portion.—Excerpt from Mr. Harrington's Address.

Mr. Harrington concluded his address with observations on professional ethics and the advisability of making engineering a closed profession by licensing the professional status of every private practitioner and of every engineer employed by others. At present many of the leading proponents of such laws advocate such meager requirements that the licenses may be had by any one claiming himself to be an engineer.

Only a few of the states require examinations and records that expose the real status of the licensee. The only way to prevent the unqualified from assuming the name is by closing the profession as has been done in law and medicine. It is argued, however, that it is not practicable for the license to show the scientific fields in which the licensee is entitled to practice. As a way out of this difficulty Mr. Harrington suggested the grading of licenses with provision for examination and reciprocal acceptance among the states.

Underwood & Underwood

FRED R. LOW
New President of the American Society of Mechanical Engineers

THE telegraph keyboard has been the actual starting point in the careers of more than one of our outstanding railroad presidents, but from telegraph operator to president of the largest professional engineering society in the world is a still greater step. Yet such is the span in the career of Fred R. Low, new president of the American Society of Mechanical Engineers. Telegraphy, it is true, played but a small part in shaping his destiny as an engineer, yet had he as a boy of fourteen taken up some other line, he might not have found spare moments to study stenography.

This led a few years later to a position as secretary to the editor of the *Boston Journal of Commerce*, which at the time was running a mechanical column. Low became interested in this department and began to study. The steam-engine indicator was just coming into use, and he procured one, making practical use of it in setting the valves on engines in various textile plants and at the same time extending his acquaintance among the operating engineers, from whom he picked up a vast amount of practical information that was to lay the foundation for his life's work. He was soon given charge of this department of the paper and conducted it so ably that he was called in 1888 to assume the editorship of *Power*, which position he has held continuously for thirty-five years.

Those years have witnessed tremendous developments in power-plant practice and in the influence of mechanical and electric power on industrial progress. This has demanded greater things of the power engineer, both designer and operator, until we see the modern large station with all its ramifications requiring the best engineering brains of the country. The influence which Fred Low has exerted in raising the prestige of this branch of the profession is reflected in the bound volumes of *Power* over that period.

Having had to dig out most of the fundamental information for himself in the early days, Low acquired a sympathic understanding for those striving to learn, and as a result his writings have revealed marked capacity as a teacher. In fact, there are many men occupying influential positions in the power field today who proudly credit Mr. Low with inspiring and helping them to success.

As an exponent of the theory that the benefit which a man derives from any society or association is in direct proportion to the effort he puts into its work, Mr. Low began to put this into practice soon after joining the A.S.M.E. in 1886. His record in the society covers many years of untiring work on committees, outstanding among which may be mentioned the Boiler Code and the Power Test Code Committees, where as general chairman of the latter he presided over twenty subcommittees. He has been vice-president, member of the council, A.S.M.E. representative on the Federated American Engineering Socities' Council and will represent the Society at the World Power Conference in England next summer. His election to the office of President is therefore a fitting recognition of a long and faithful service which has provided a background that his friends feel will make for a most successful administration. — *A. D. Blake, Associate Editor.*

Power Subjects Dominate A.S.M.E. Meeting

The majority of the sessions held by the American Society of Mechanical Engineers at the Annual Meeting Dec. 3 to Dec. 6 were devoted to power generation and allied subjects. Of especial interest were the papers on the storage of coal, heat cycles, preheating of furnace air, hydro-electric problems, oil engines and water measurements. While certain of the papers were purely theoretical and discussed possibilities rather than actualities, the fact that engineers are willing to devote time to the planning of the power plant of the future indicate they are alive to the necessity of a more economical use of the country's resources. Some of the papers were published in abstract form in *Power* Dec. 4. Others of interest to power engineers are abstracted in this issue together with the high points of the discussions.

Problems Involved in Coal Storage

THE subject of coal storage was considered at a meeting held under the auspices of the Material Handling Division of the American Society of Mechanical Engineers Dec. 5. The importance of the subject was indicated by the large attendance and the amount of discussion invoked by the papers, extracts of which are given below:

Coal Storage Systems

BY H. E. BIRCH AND H. V. COES

A constant and ample supply of coal is as necessary to the power house as is a constant and ample supply of water, but unfortunately the coal supply must be maintained at the plant, necessitating a considerable investment in both handling facilities and in coal inventory. This seems to be necessary, since past experience has proved that there are too many links between the unmined coal and the boilers. Mine strikes, railroad strikes, severe winters, high-priced coal, poor quality of coal, lack of transportation facilities, are some of the reasons for storing coal against future needs.

The amount of coal storage desirable depends on the factors of distance from source of supply, adequacy of rail or water connections, the seriousness of a possible shutdown, the probable future growth of the plant, and perhaps other local considerations which must be weighed separately for the particular plant in question. It is necessary to keep well in mind the possible future expansion of the plant, not necessarily installing today for the future, but designing in such a manner that the future can be taken care of without scrapping equipment.

Unloading railroad cars presents a complex problem, since the types vary considerably and the coal may be frozen solid in the car. In the East practically all the cars are the bottom-dump type, and the usual practice is to employ a hopper in a pit beneath the railroad track, from which coal is taken by the material-handling device. This is true even where a grab bucket is used, in order to avoid the loss of time cleaning out the hopper bottoms of the car.

It is important when considering large installations to know whether the specified hourly capacity is based on what the equipment can be made to do in a one-hour test, or whether the intention is that the specified rate must be maintained over a ten-hour period. Is the unloading rate 250 tons per hour, or is it 2,500 tons in ten hours? There is a vast difference between these two capacities.

Perhaps the earliest type of storage system was the railroad trestle. Many plants were built to receive their coal on elevated trestles, but today it is becoming obsolete as a complete system. Some trestles are still being built, but most of them because topographical considerations force them.

Obviously, we cannot afford the expense of covering the entire storage area with trestles, and must therefore use it merely as an auxiliary to the complete system, primarily as an unloading means and, in the case of a locomotive crane, as a means of forming a long pile, and so eliminating the necessity of the crane traveling with each bucket load.

The trestle-and-crane system must have some means of transporting the coal when reclaiming. Obviously, the crane cannot be permitted to do this for each small load. The most satisfactory way is to have the crane reload into the railroad car or into a smaller privately owned car, and let the crane shift it to the boiler house. The car should be of the bottom-dump type, to avoid the time lost if the crane has to dig out the coal. The unloading hopper in this case should be extra large, otherwise the crane will have to wait until the conveying system has unloaded the car through a small track hopper.

The locomotive crane and conveyor system is practically identical with the previous one, except that a scraper flight conveyor or a belt conveyor is used to form the continuous wedge-shaped pile from which the crane stocks out. It has advantages over the previous system in that all the disadvantages of the railroad trestle are eliminated, and that the locomotive crane is confined to a single duty and does not have to act as a shifting locomotive. It reloads into a traveling hopper, which feeds the conveyor.

The cable drag scraper is a device for storing coal on the ground and reclaiming it with the same equipment. It is designed for this service only and cannot perform any other, such as unloading boats or railroad cars. Such being the case, coal must be unloaded by some other device and delivered to some point within the boundary of the system, from which point the scraper can stock it out to fully cover the area. When reclaiming, the scraper position is reversed on the haulage cable, the coal being delivered back to the same initial pile or to any other desired point within the storage area.

The rope cableway system consists of a single-span

cable supported by towers at each end and which carries a grab bucket hanging from a carriage or trolley. If a simple fixed span, it is open to the same objections as the monorail telpher or fixed conveyor, in that it stores the coal in wedge-shaped piles and cannot reclaim much more than 50 per cent of the storage. Sometimes the cable ends are anchored on movable towers in order to cover a rectangular storage area, in which case serious limitations are met. When this is done, a railroad track is usually run along one side of the storage area and the grab bucket digs directly out of cars.

Portable conveyors have a field all to themselves for very small capacities where the installation of the larger system cannot be justified. They may be of the belt-conveyor type or the chain-and-bucket-elevator type. These devices have been used in some instances where equipment of a more permanent nature should have been used.

The belt-conveyor stacker system uses a long belt conveyor built on the ground, and a stacking device that is essentially an immense tripper to which is attached a short pivotal belt conveyor. The ground conveyor discharges the coal to the stacker, which can swing through 180 deg. of arc and can be raised or lowered in a vertical plane to prevent dust and breakage when discharging. The stacker travels on ground tracks which span the main belt conveyor, thus permitting coal to be stored on both sides.

Factors in the Spontaneous Combustion of Coal

By O. P. Hood
Chief Mechanical Engineer, United States Bureau of Mines.

In order that the engineer may intelligently consider the phenomena of spontaneous combustion of coal, he must have some general ideas about the coal substance, about the character of coal surface, about the atmosphere in which it may be immersed and about slow combustion. Carbon, hydrogen and oxygen products of fairly definite chemical combination have been brought together in ages past, and a practical equilibrium has been attained in the substances we find in the ground as coal. Change the surrounding condition, however, and recombinations may begin again. These may be very slow at normal temperatures, but at elevated temperatures they are rapid, and we call the process combustion.

A particle of coal removed from the mine, is surrounded by air from which it had been shielded for ages, and its moisture, temperature and pressure environment become different.

It is the freshly broken coal surface that experiences the greatest change and finds its equilibrium most seriously upset. Small amounts of heat may be generated in other ways. With the coal substance are minerals, and these also find themselves in strange environment and proceed to change. The amount of the activity will vary with the particular coal, the amount of surface and the environment. It will be rapid at first and finally be so slow as to pass out of our interest. Being a surface phenomena, it will become noticeable only when the surface is large.

When a coal surface is elevated in temperature above that of its surroundings, it will lose heat by conduction, radiation and convection. The body of the piece will itself be heated by conduction. Obviously, if the mass is large compared with the surface, as in coarse coal, the rise in temperature of the mass will be small as compared to the condition of fine coal where the total surface is large compared to the mass. The ordinary daily barometric temperature changes produce a breathing in such a pile, and if any portion becomes perceptibly warmer, a chimney effect is possible. If the movement of air be reduced to zero, the oxygen is soon completely engaged with new relations, and the very small rise in temperature is stopped. If there is a considerable movement of air, any heat generated is carried away. There is, therefore, some rate of air movement too slow to carry heat away but sufficient to keep up the supply of oxygen and produce the maximum heating effect. The problem of coal storage is to prevent this condition, or if it exists, to discover it before a critical temperature is reached, and rearrange and cool the particles at the local point of heating.

A conical pile of run-of-mine coal made by dumping from one point will have a central core of small-sized particles. Air exchange through this will be extremely slow. Coal sizes are classified by such handling and will grade from the finest in the center and top to the coarsest on the bottom and lower flanks where there is ample ventilation. Between these extremes, part way up the flanks and below the surface, where the coal is fine enough to give a large surface of fresh broken coal and the ventilation too low to carry away the heat and yet sufficient to keep up the oxygen supply there is likely to be a most favorable condition for spontaneous combustion. The hazard is thus greatly increased by allowing this classifying action in building the pile.

The application of these thoughts to practical coal storage lead to the following conclusions, which seem to agree with best current practice. There must be no heat added to the coal from outside sources, such as hot walls, steam pipes, oily waste, etc. If coal can be got into the pile in pieces that will stay on a ¾-in. bar screen, there will be no heating. The pile may be of any height provided there be no fines. Where mixed lump and fine coal must be stored, the pile should be so built as to avoid segregation of sizes. The production of fresh surfaces by breakage just before going into storage, pre-disposes to spontaneous combustion unless the crushing is so fine and the packing of the pile so dense as largely to exclude air circulation. Coal should be so stored that its temperature conditions can be daily inspected. When any portion reaches a temperature of 140 to 150 deg. F., there is a high probability that within a few days or weeks a destructive temperature will be reached. If the temperature reaches 160 or 180 deg. F., there is almost a certainty that a destructive temperature will be reached. The best remedy is to move the warm coal so that it may cool.

Economic Phases of Coal Storage

By F. G. Tryon and W. F. McKenney

This paper, which embodies the results of a study made by the coal-storage committees of the Federated American Engineering Societies, points out the economic advantages of coal storage. Storage is not a new thing, since every year there are large amounts purchased and stored away. On Sept. 1, 1923, reports show that the average days storage for all power plants was forty-six. These reserve stocks were scattered over the entire country, but were especially large in New England and along the Great Lakes. The authors

gave a number of curves showing the variation in the spot market price for a number of years. These revealed that the disturbances in the market are always more marked in even years, as a result of the negotiations of wage agreements.

The authors expressed the belief that in the regions west of Pittsburgh a consumer who counts the cost of storage may expect to derive a benefit from the seasonal variation in price, year in and year out, sufficient to meet a considerable part of the storage expense. They also emphasized the opinion that in these recurring periods of plenty and scarcity, the difference in spot price does not tell the full financial loss to the improvident consumer. Many a plant had to take substitute coal unsuited to its needs and obtained from it so much lower efficiency that the actual cost per heat unit developed increased in higher ratio than the simple increase in price. Besides, many of the emergency supplies of coal, obtained perhaps under priority order, come from districts remote from the point of consumption and are therefore subject to high freight charges, so that the differential in actual cost to the consumer becomes still higher.

If these periodic crises in coal supply are to continue, there can be little doubt that a consumer will save by storing unless his connections are such that he is certain of a steady supply even in the event of a great strike. Few consumers are in this happy position of guaranteed supply.

There is already talk of a bituminous strike next April, when the present wage agreements expire, but to attempt to prophesy would be out of place here. If there is no strike it will have been in part prevented by consumers who have taken the precaution to store; and if this general preparedness helps the operators and the miners to reach an agreement peaceably, the expenditure has been worth while. The holder of a fire-insurance policy need not regret that he has no fire.

Discussion

In the discussion, J. E. Davenport pointed out the heavy burden placed upon the transportation lines by reason of the heavy seasonal movement of coal. The coal mines have a practice in rush times to order far more cars than could possibly be loaded; failure to deliver these empties is immediately branded as proof of a car shortage. To meet these unreasonable demands would entail the expenditure by the roads of three-quarters of a billion dollars. The speaker felt that the solution was to be found in a more liberal storage by consumers during slack times.

C. G. Spencer declared that proper piling would eliminate all danger of fires in the coal storage. The coal should be placed in layers to prevent a separation of the lump and fine coal.

George Orrok of the New York Edison Co., stated that he did not believe that storage was economical. Although the New York Edison stores over a half million of tons, he felt that the advantage was more in the way of insuring continuity of service. Stress was placed on the necessity of storage at the pit head.

Dr. Richards, of Lehigh University, found in experimenting with Illinois coal that storage did not cause noticeable damage to coal even after being left as long as ten years in a pile. Fires could be eliminated by proper placing of the coal.

A. A. Adler felt that the storage of pulverized coal was unpractical owing to the increased surface area of the particles and the large amount of air entrained in the coal.

Many Problems in Water-Power Development Discussed at Hydro-Electric Sessions

THAT many of the hydro-electric developments in this country have been financial failures, that many of these projects would never have been attempted if proper preliminary engineering investigations had been made, that superpower systems were not going to reduce materially the cost of power below present values, that there are small possibilities of reducing the cost of power below present levels, that water power in most cases had to be developed in conjunction with steam plants to make the project successful and that the high cost of hydro-electric developments and transmission made it difficult for water power to compete with steam-electric power, unless the transmission distances were comparatively short or the price for fuel comparatively high—these were some of the opinions expressed at the hydro-electric session held on Wednesday evening, at which Lewis B. Stillwell presided.

In a paper, "The Principles Underlying Hydro-Electric Development," John R. Freeman made a comprehensive statement of the fundamentals that must prevail in developing hydro-electric power for the growth of industry and the welfare of the people. Mr. Freeman said that the very fundamentals can be quickly stated: A hydro-electric prospect must show a profit on the investment, and it should be so developed as to contribute to public welfare in the highest degree. These principles, said the speaker, seem so self-evident as to require no extended discussion, but to prove up, on their application to a particular prospect, may require an enormous amount of work. He said:

The fundamental question about water power that I heard most debated forty to fifty years ago was its relative cost compared with steam power. Rates for water at Lawrence, Mass., were about $20 per horsepower-year, for the right to draw water for power from the canals nominally 16 hours per working day, but actually about 10 hours. At Holyoke the price was much smaller.

Since those days the cost of coal has doubled, but higher steam pressures, larger power units, the steam turbine and the economies of the central station have cut coal consumption per horsepower-hour in half. The unit costs for machinery and material have doubled. Although the efficiency of the hydro unit has increased at best only from 83 per cent to 93 per cent, the costs of installation, maintenance and supervision have been held down by a wonderful concentration of power into single units and by a revolution in the features of design for large developments, so that with all these changes there has been remarkably small change in 40 years in the cost of hydro or steam power in large quan-

tity, reckoned at the prime mover. And in all these new schemes of superpower—St. Lawrence power or steam stations at the mouth of the mine—I see no chance for any substantial reduction in power cost at wholesale below that which we now enjoy.

Let us not be too optimistic about cheaper power coming from the St. Lawrence or from coal mines, over the superpower line to central New England or Greater New York. I, for one, strongly incline to the belief that factories at Lawrence will be glad to get water rights at the old figure of $20 per hp. 50 years hence, and that 1c. per kw.-hr. (perhaps 1.25c.) at wholesale in big blocks will be the lowest price or cost attainable by the great factories at Lowell and other Mid-New England industrial centers 50 years hence and in all the years between. The great benefits of the superpower system and of the distant sources will come from holding prices down to the present levels, from a more abundant supply in lessening the investment of capital by the industrial pioneer, and in many other ways than by reducing present costs per horsepower-hour.

In hydro-electric practice the facility of long-distance transportation of power is the outstanding achievement of the past twenty years, and one of the most interesting features is the way steam-power and water-power installations at widely separated places, each pumping current into opposite ends of the same line, have come to supplement each other, economizing both power and transmission, uniting and interchanging the variable power developed in the mountains or foothills from water that is plenty in springtime but scanty in midsummer, with steam power developed at the seacoast from sea-borne coal or oil. It will surprise many to learn, for example, that more power is sent forth from the Narragansett steam station in Providence from its 60,000-hp. steam turbine, back into the country over the lines of the New England Power Co., than is brought to the industrial centers near the coast from the northern Connecticut River and its tributaries. Hydro-electric companies on variable streams less favored with reservoir sites are becoming connected up with steam reserves at the seaboard, and all are rapidly becoming interconnected.

Misunderstandings About Water Power

There is a widespread popular misunderstanding about the present demand for water power. Many think there are great chemical industries earnestly seeking hydro-electric power. The chemical engineer of large vision is today looking for cheap B.t.u. far more than for cheap kilowatt-hours. This statement may seem strange to one familiar with the vast electrochemical industries at Niagara or with the vast use of power for making aluminum out of purified bauxite, until he has done considerable investigating or has tried to find a customer for a big block of power in the chemical industries. A prominent and successful Canadian chemical engineer told me that at the close of the World War he sought to establish himself in some large line of manufacture of chemical products, and familiar with the vast undeveloped water-power resources in Canada, upon rivers other than the St. Lawrence and requiring smaller first outlay, he sought far and wide for chemical uses for this power, but each time the trail led him away from the kilowatt-hour to the cheap B.t.u.; in other words, to cheap coal, and finally he located in the coal fields of West Virginia.

I know where, in Canada, a million horsepower can be developed in blocks of not less than 100,000 hp. at almost unprecedentedly low cost, perhaps $100 per kw. of primary power, if only profitable use could be found for blocks of this size; but until the chemical engineer comes forward with new uses, as perhaps in iron smelting or new economic processes for fertilizer, or until steam coal becomes worth $15 per ton at great business centers, I fear such sites have no present substantial commercial value.

And as to the demand for big blocks of cheap hydro-electric power to be used in the manufacture of cheap fertilizer, the public and their deputies in legislative halls have become badly befogged and misled, particularly in the discussions about the development of cheap water power at Muscle Shoals.

The old spectacular processes for the fixation of nitrogen developed by German science and capital in Norway a dozen years ago, with flaming electric arcs 10 ft. long and of 2 per cent efficiency, were long since outclassed by processes in which a mysterious catalyzer under favoring conditions of great pressure and high temperature, is doing the work with a relatively small call for power. The nitrogen research bureau of the federal government, with the vast sums they have spent on research, should be able soon to clear the foggy atmosphere that now surrounds the relation of cheap fertilizer to water power.

I have made the previous statements to fix attention strongly on the fact that the value of a prospective hydro-electric site is *not in the water and its fall,* but *solely in the use to which this power can be put* and the rate at which the total output can be absorbed in industry, so as to pay interest upon the capital invested.

There is more than five million horsepower now running to waste along the St. Lawrence. It is hard even for an engineer to comprehend what five millions of horsepower of energy means, and difficult to translate it into the terms of every-day life. This is about the sum total of electrical generating capacity today in all the central stations, steam and hydro, of New England, New York, New Jersey and Pennsylvania. And this St. Lawrence power, being 24-hour power with ample storage for conservation, is equivalent to providing about three times the number of kilowatt-hours per year now used in lighting, railways, manufacturing, chemistry and metallurgy, etc., throughout this vast industrial and commercial region.

How soon do we need it? What will it cost? How much can we pay for it? How much of it is needed? These are its fundamental problems.

Discussion

In discussing Mr. Freeman's paper, John P. Hogan called attention to the lack of accurate engineering data available on many hydro-electric developments when they were undertaken. For this reason so many hydro-electric developments have been financial failures that it is now difficult to promote such projects. Some of the causes of these failures have been underestimating the costs and underestimating the water available, lack of knowledge of underground conditions, all of which in many cases was due to the owner's efforts to keep down the cost for preliminary work.

George A. Orrok gave a comparison of the costs of producing power in a large steam station located in a large city and that of producing this power in a hydro-electric plant 300 miles away and delivering it into the district to be supplied from the steam plant. This

study showed that unless the cost of the water power was low and the load factor high, such a development could not compete with steam even with coal at present prices. This paper will be published in an early issue.

Harold W. Buck said that the question of distribution of power from water-power developments was inseparable from the development of power. Mr. Buck expressed the opinion that the superpower idea is being overworked and is misleading the public to believe that something was going to take place that would result in greatly reducing the cost of power and said that he did not believe that superpower was going to reduce the cost of power. The speaker showed by a number of curves the importance of developing water power in conjunction with steam power not only to keep the cost of the power down, but to utilize the water to the best advantage.

Water-Measurement Session

At the Water-Measurement Session, held Wednesday afternoon, at which William M. White presided, three papers were presented: "Flow of Water in Short Pipes," by O. W. Boston; "The Salt-Velocity Method of Water Measurement," by Charles M. Allen and Edwin A. Taylor; and "The Gibson Method and Apparatus for Measuring the Flow of Water in Closed Conduits," by Norman R. Gibson. The following is an abstract of Mr. Boston's paper:

This paper presents the method employed by the author in determining the frictional resistance of water flowing in short pipes of one inch to eight inch diameters, having lengths three times the diameters. Data for mathematical interpretations are obtained by allowing a tankful of water to empty through the pipes. Values for the coefficient of discharge of the pipes are computed and tabulated for heads up to about seven feet.

The author points out that in general, water will enter a short pipe under the same conditions as it discharges through an orifice. Just inside the pipe the area of the stream is contracted so that the pipe does not flow full. Farther along the pipe this area is increased to that of the pipe and the pipe flows full. A partial vacuum exists in the tube where the pipe does not flow full, and it is this partial vacuum that increases the discharge of the short pipe over that of the orifice. The discharge coefficient is increased from about 0.6 for a circular sharp-edged orifice to about 0.8 for a short tube.

In the tests a one-inch short pipe was used in the initial set-up. The first time that the water was emptied through it, the pipe did not flow full but acted as an orifice, the stream of water having the appearance of a solid glass rod. The discharge was then stopped by plugging the tube on the discharge end and subsequently released. This caused the pipe to flow full at the discharge end, which gave the values of an orifice in the first case and of a short pipe in the second. The fact that the 6-in. and 7-in. short pipes discharged as pipes in some cases and as orifices in others, while the 8-in. pipe discharged only as an orifice, indicates that as the diameter of the pipe is increased the ratio between length and diameter should also be increased. It is believed that the friction derived from the error in using a ratio of 3 to 1 between length and diameter instead of the theoretically correct ratio has not appreciably affected the results obtained. The 8-in. pipe, when discharging as an orifice, gave results that check very well with the values given by other experimenters.

New Methods of Measuring Water

Messrs. Allen and Taylor in their paper described a new method of water measurement called the salt-velocity method. The authors outline the theory and development of the method, describe the apparatus and methods of computation used in laboratory and field tests, give an account of several commercial tests, and show that the method has a high degree of accuracy and reliability. In this method a small quantity of salt solution is introduced into the water in a pipe line and its time of passing between two given points is determined by electrical methods. From this time and the cross-sectional area of the pipe line the volume of water flowing can be easily determined. An abstract of this paper will appear in an early issue. In presenting the paper, Mr. Allen compared this method to the screen or the float method of measuring water. It was explained that the advantages of this method were its simplicity, accuracy and the small amount of salt used to make a test.

The purpose of Mr. Gibson's paper is to explain a new method, known as the Gibson method, of determining the rate of discharge or quantity of water flowing in a pipe or other closed conduits and to describe the apparatus used for the practical application of this method in testing the efficiencies of waterwheels in hydro-electric power plants. With this method an apparatus is used for obtaining a record of the pressure changes taking place in a closed conduit when the flow is retarded. This record is called a pressure-time diagram and from it the velocity of the water in the conduit at the time of arresting the flow, can be calculated. An abstract of this paper will appear in an early issue.

In presenting his paper, Mr. Gibson called attention to the difficulty of measuring the flow of water to hydraulic turbines by the old methods, as the size of the units and consequently the size of the waterways increase, also to the desirability of being able to measure the flow of water to the unit with the least interference to its operation. With his method all the field work of making a test on the largest hydro-electric unit can be done in two or three hours, and even during this period the unit is only out of service part of the time. All the preparations for the test can be made without interrupting the unit's operation. Mr. Gibson said that in taking approximately 1,000 pressure-time diagrams with his device, they always told the story of the water flowing in the pipe line or penstocks, and that no experience in the last three years with this method would lead one to doubt the accuracy of the method.

Discussion by both manufacturers and operators of hydraulic turbines attested to the accuracy of both the Allen salt-solution method and the Gibson "pressure-time" method of measuring the flow of water to hydraulic turbine. The discussion brought out that by the use of these methods it was possible to obtain a more accurate measurement of the water than of the load on the unit, the maximum error being well under one per cent. In two independent simultaneous tests made by the Gibson method on a 60,000-hp. unit operating under 315-ft. head, the maximum variations in results were from ½ to 1 per cent, with the curves plotted in each case passing through practically the same values.

High Pressures and Heat Cycles

STAGE heating seems already established. High pressures and reheating are finding many devotees. The air preheater, already established in Europe, is receiving serious engineering consideration in America. In a word, the rapid approach toward the practical efficiency limits of present customary cycles, pressures and temperatures has directed the attention of power-plant engineers to the possibility of fundamental changes in operating conditions. Though few of the principles involved are new, the countrywide movement in this direction is no more than a year or two old. Last December at the A.S.M.E. annual meeting the papers of Orrok and Helander provoked much thought and discussion along these lines. Since then technical journals and local engineering groups have contributed largely to the subject. Finally came this year's annual meeting of the A.S.M.E., with five papers that are an important addition to the permanent literature on the subject. These papers, abstracts of which appeared in the Dec. 4 issue, are as follows: "Margins of Possible Improvements in Central-Station Steam Plants," by Ernest L. Robinson, of the General Electric Co.; "High Pressure, Reheating and Regenerating," by C. F. Hirshfeld, of the Detroit Edison Co., and F. O. Ellenwood, Professor of Heat Power Engineering at Cornell; "Economy Characteristics of Stage Feed-Water Heating by Extraction," by E. H. Brown and M. K. Drewry of the Allis-Chalmers Manufacturing Co.; "Reheating in Central Stations," by W. J. Wohlenberg, Assistant Professor of Mechanical Engineering at Yale; "Boiler Test Results with Preheated Air," by C. W. E. Clarke, of Dwight P. Robinson & Co.

Brief Outlines of the Papers

Mr. Robinson outlined in a general way the ultimate possibilities of various cycles, including the combination mercury-steam-ammonia cycle. He concluded that for the present we were practically limited in the temperature to 750 deg. and that the greatest immediate prospects lay in higher pressures with stage heating, preferably accompanied by stage moisture separation. Mr. Robinson also favored the air heater, although he felt there might still be a place for the economizers. Hirshfeld and Ellenwood, after a more extensive study, reached practically the same conclusions.

The paper of Brown and Drewry was notable for its presentation of a standardized method of computing actual cycles. Application of this method to a study of stage heating led the authors to the conclusion that the practical line of advance lay in the regenerative cycle.

All these papers mentioned the possibility of still greater gain by a combination of the bleeder heating and steam reheating. They also agreed that with present temperature limits pressures about 1,000 lb. offered little or no practical advantage. In these respects Professor Wohlenberg agreed, but his investigation led him to favor the straight reheating cycle over the straight regenerative.

The paper by C. W. E. Clarke gave a favorable report of air preheater tests at Colfax, showing an increased boiler efficiency of from 5½ to 7 per cent, increased CO_2, lowered gas temperatures beyond the superheater, and general operating improvements.

In addition to the heat cycle papers and that on the Air Heater there was a paper on "Boiler Plant Economics," by N. E. Funk and F. C. Ralston. Since no abstract of this paper was given in the Dec. 4 issue, its contents are outlined in the following paragraphs:

This paper is divided into three parts. In the first a rational formula is developed for expressing boiler-plant performance and for the determining from boiler-plant efficiency guarantees or tests, the values which the constants in the formula take for any given boiler. The second part is devoted to the application of boiler formulas in solving problems of operation at maximum boiler efficiency, at maximum daily efficiency, etc. In part three the minimum total cost of operation is taken up with due regard to investments, operating charges, as well as determining the number of boilers economical to install for a given load curve.

The authors begin with a well-known fundamental relation—

$$B.t.u.\ input\ per\ hour = \frac{B.t.u.\ output\ per\ hour}{Efficiency}$$

In this equation, Y is taken to represent the left-hand member, and X the boiler output rate, which is the percentage rating at which the boiler is operating, expressed as a decimal. One hundred per cent would be expressed as 1.00. This provides a fundamental form of equation. The various factors which affect the curve of the fundamental equation include that of power taken by the draft fans, etc., the influence of turbine water rate on the cost of electrical energy for driving auxiliaries at various loads, variations in superheat, etc. The fundamental curve is derived for a given boiler plant where the output ratings are abscissas and the quantity Y ordinates. The curve was derived by the authors, plotted by the side of one found from tests. These agree very closely. The authors have developed charts for applying the known quantities of operation, so as to obtain constants of the formulas which they describe.

The next two parts deal with a mathematical treatment of these formulas by which the maximum efficiency of operation under various conditions may be figured out. Charts are introduced indicating methods for doing this work.

Prof. Christie Calls for More Efficient Air Heaters

The discussion was started by Prof. A. G. Christie, who had prepared written comments on three of the papers. Analyzing the paper of Mr. Clarke, Professor Christie showed that the gain in efficiency with the air heater at Colfax was due not only to the recovery of heat from the flue gases, but also to a reduction in the percentage of excess air, lower carbon content in the ash and a lower gas temperature at the damper. Expressing the efficiency of the preheater as the actual air-temperature rise divided by the difference between the entering flue gas and entering air temperatures, the efficiency at Colfax is 32.4 per cent, which seemed to be higher than the average obtained with this type of heater.

What is needed today, Professor Christie said, is a cheap form of air preheater that will be permanent, remain clean and give efficiencies of from 70 to 80 per cent. The idea of using sheet-steel plates for regenerators is an old idea. Some bright genius, he thought, should be able to develop a regenerative form of air

preheater cheap to build, mechanically correct and reliable in operation. Such a preheater combined with high-stage turbine blading would produce an attractive heat balance.

The paper of Brown and Drewry was referred to by Professor Christie as the most comprehensive treatment published to date on this subject. He recommended the methods outlined for heat-balance calculations. After presenting some formulas that he had found useful in the solution of heat-balance problems, he stated that engineers in this country are just starting to appreciate the improvements in economy that may be attained by the use of air preheaters in conjunction with present equipment.

Differences in Conclusions Pointed Out

It would be of interest and assistance to engineers, said Professor Christie, to know whether turbine designers could confirm Professor Wohlenberg's claim that the efficiency is a function of the adiabatic end point. Owing to these differences in basic assumptions the conclusions reached were somewhat different, Professor Wohlenberg finding about 1,000 lb. to be the most economical point, while Hirshfeld and Ellenwood (except for the Rankine cycle) do not reach a minimum even at 1,200 lb.

Discussing the paper of Hirshfeld and Ellenwood, Professor Wohlenberg emphasized the difficulty of constructing turbines with high efficiency over all pressure ranges. He was a little surprised to find that the authors used a lower turbo-generator efficiency for the regenerative cycle than for the Rankine cycle. While admitting that it was practicable to apply a simple factor to the theoretical thermal efficiency to get the actual in the case of the Rankine cycle, he doubted whether this was justifiable in the case of bleeder cycles.

It all came down, he said, to the question of getting accurate data on the effect of external conditions on the internal losses. With conditions assumed, the theoretical results obtainable with various cycles can be definitely determined. The debatable points arose in reducing the theoretical to actual efficiencies. The field of ignorance in this respect, he said, was still large, particularly when dealing with high pressures.

Air Heaters not Always Successful

Discussing Mr. Clarke's paper on "Air Heater Tests," R. Sanford Riley said that not all preheater tests had been as successful as those at Colfax, probably due, he thought, to lower grades of coal, particularly those whose ash content and composition inclined them to slagging. Some foreign tests with air preheaters had shown an actual reduction in efficiency in spite of the partial recovery of the flue loss. Leo Loeb, of Day & Zimmerman, Philadelphia, commenting on Mr. Clarke's paper, concluded that the gain in the Colfax tests came from increased boiler-absorption efficiency and increased radiant heat, and said that this was confirmed by the test data on the temperatures of the fuel and the furnace wall.

A number of the papers were discussed extensively by Linn Helander. Referring first to that of Brown and Drewry, he objected to the use of Mollier diagrams to determine the relative merits of different types of blading and to the conclusion that turbines with impulse stages in the high-pressure end were less suitable for bleeding, because they extracted less energy from the steam before it went to the heater. He thought there was also a fallacy in the generalization that air pumps always gave a better station economy than steam-jet air ejectors.

In reference to the paper of Brown and Drewry, Mr. Helander felt that it would have been better to have avoided unnecessary error by dividing the cycle into two parts, first from throttle steam to the reheater, and second, from the reheater to the condenser. The second part, on this basis, would correspond closely with standard practice and could be accurately figured, leaving the uncertainty only in the figuring of the first part. From calculations made in this manner for a pressure of 550 lb. Mr. Helander concluded that the best reheat pressure was 125 lb., considerably lower than that given by the authors, and that the net gain for reheat approximated 5 per cent under these conditions.

Proposes New Diagrams for Bleeder Cycles

Commenting on the papers of Hirshfeld and Ellenwood, and Professor Wohlenberg, Mr. Helander suggested that the problem might be clarified by drawing separate temperature-entropy diagrams for the portions of the steam that went to the condenser and the bleeder heater. He also felt that it was a mistake to limit consideration to the bleeding of saturated steam, since there was a considerable theoretical gain to be had by bleeding superheated steam. He called attention to the fact that bleeding raises the best temperature for reheating and that it also, at least theoretically, reduces the benefit of reheating.

Mr. Helander felt that certain assumptions made in Professor Wohlenberg's paper, such as the use of the same steam heating temperature at all pressures, adversely influenced the efficiency at high pressures, and that the method of applying turbine efficiencies derived from non-reheating tests to turbines with reheating was not correct, although it was partly compensated for at certain points by other assumptions. By splitting the computation into two parts, these variables could have been more accurately handled.

Referring to the paper of Hirshfeld and Ellenwood, he doubted the practicability of applying a factor directly to the efficiency of the ideal cycle, as well as that of determining feed-water temperatures on the basis of the internal losses in the turbine.

Why not Bleed Superheated Steam?

Discussing the paper of Hirshfeld and Ellenwood, Frank S. Clark, of Stone & Webster, said that consideration must be given to certain factors not dealt with, that is to say to other possibilities of improving efficiency. For example, a station might be divided into two portions, one a thousand or twelve-hundred pound section with reheating and regeneration to operate continuously on the base load, and the other a less-efficient section to carry the fluctuations at lower pressure on the Rankine cycle.

Another thing to be considered is the possibility of bleeding in the superheated as well as in the saturated zone. Reheating might be accomplished at the turbine at constant pressure by saturated steam, or, if higher temperatures were desired, by saturated mercury vapor. In deciding upon the conditions to be used in an actual installation, it was important, he said, to remember that cost of equipment does not go up in a smooth curve, but by jumps. This might change the

optimum pressures and other operating conditions.

B. N. Broido, development engineer with the Superheater Co., made some comments on that part of Professor Wohlenberg's paper that referred to a radiant-heat reheater. Mr. Broido preferred the separately fired reheater for such work. It was, he said, much more efficient than generally thought, 70 per cent being frequently obtained. Such a reheater would fit in well in a plant with electrically driven auxiliaries. The reheating of steam by saturated steam might have a limited application. Mr. Broido felt that the radiant-type superheater would be subject to large variations in temperature. In concluding his discussion, he showed efficiency curves for high-pressure plants built some years ago in Germany.

So much discussion developed that it was necessary to extend the session well into an afternoon. With regard to the paper by Mr. Clarke on preheated air, Mr. Hirshfeld advised that the results were unsatisfactory from the viewpoint of the test without a preheater. The performance under these conditions was considerably below the expected standard, and had this been up to the requirements, the advantage of preheating would not have appeared so favorable. On the other hand, calculations involving the use of preheated air check very closely with Mr. Clarke's results and on the whole he believed these gains were attainable in practice. It appeared that there had been no abnormal trouble with the refractories at Colfax due to the use of preheated air during six months. The operating force preferred this method on account of its producing less trouble with clinker than before the preheater was installed. From experience abroad it appeared that great trouble with refractories was to be expected in the use of preheated air.

The discussion was quite general in regard to the remaining papers. Several speakers referred to Fig. 20 of the paper by Hirshfeld and Ellenwood, commenting on the misleading phraseology in regard to the ordinates. It developed finally that this was chosen in order to line up with the Power Test Code. This paper was criticized for not including the method and calculations by which the results could be checked. The authors made it clear that results were of a comparative character and not meant to be numerically correct. The assumed conditions were of a special character picked out for ease of calculation and also from the fact that they differed from any recognizable installation at the present time. Turbine efficiencies and other quantities were in many cases lower than would be represented by machines designed in accordance with special conditions.

The advantage of bleeding small steam engines which consumed about 60 per cent of the fuel at the present time was emphasized. The fact that economizers are seldom employed in small plants and that the steam engine cannot utilize as low a vacuum as the turbine, makes bleeding especially attractive. The need of heaters in small plants containing steam turbines was touched upon. These are not apparently manufactured to any extent commercially, it appeared from the discussion.

The economy of medium pressures and temperatures against that obtained in the so-called superpower plants was compared by John Lawrence as being rather favorable to the former class. On the other hand it appeared that in some cases high pressures and temperatures were justified and in one case a large plant designed for steam at 365 lb. with 4-stage bleeding, showed 6 per cent more capacity than one for the same price with 205 lb. at the throttle, and 3-stage bleeding. It was suggested that before going to high pressures the present results with maximum conditions be investigated to see if the gain was commensurate with the expenditure.

In his closing remarks, Mr. Funk illustrated the simplicity of application of the formulas and curves which otherwise appeared very complicated.

The Diesel Engine as a Prime Mover

UNDER the auspices of the Oil and Gas Power Division of the A.S.M.E. a meeting was held on Dec. 6, at which the oil engine was considered from both a constructural and an economic viewpoint. That the internal-combustion engine is growing in importance as a prime mover was attested to by the large audience and the number entering the discussion after the reading of the papers, extracts of which follow:

The Solid-Injection Oil Engine

BY H. F. SHEPHERD

History shows that oil-engine development, after the first basic proposals, was in reality not so much a problem in invention as a labor of acquisition of facts and figures necessary to determine the proper proportions and arrangements of the devices originally suggested. It is now in order to sum up the individual problems.

The phenomenon of cracking was known to refiners as early as 1861 and was used as a process soon after, but the engine trade did not give it intelligent and practical consideration, as far as the author has been able to learn, until as late as 1903. In that year William J. Crossley and Wilfred Le Plastrier Webb, in a patent application covering the use of water injection in their particular mode, stated that any liquid or vaporized hydrocarbons which come into contact with the overheated parts of the vaporizer would decompose or partly decompose, forming carbon or tarry deposits.

Water injection was then used to limit the vaporizer temperature. In early engines the hot surfaces were invariably too hot, but by the use of water injection at different rates and economy tests it was learned that best results were attained at vaporizer temperatures below red heat. For a broad range of fuels the optimum temperature is very close to 850 deg. F. Above this the decline of desirable characteristics is rapid. Little change takes place between 680 and 850 deg. F.

At the A.S.M.E. Annual Meeting in December, 1915, Louis Illmer contributed a paper on oil-engine-vaporizer proportions. This paper marked the passing of the Hornsby-Akroyd engine, but the section dealing with the conductivities and the paths of heat flow remains most valuable in determining the hot walls of a combustion chamber within the temperature requirements.

The external hot surface is now *passe*, but the piston head is a similar influence even in modern engines if

the spray is directed against it and must be treated in the same way. If the piston shows over 800 deg. F., it should be thickened. This applies to full-load operation. If the piston is too cold at light loads, some of the known means of compensation must be applied to increase the charge heat.

When the piston of a solid-injection engine serving as the vaporizer reaches such a size that cooling is required, a new application of the principles of conductivity is made. Manifestly, it is not feasible to spray against or along a jacketed piston wall any more than against a jacketed cylinder head. Accordingly, a long path is provided for the heat flow from the piston-head surface to the piston jacket.

The solid-injection engine working at its best is never a Diesel-cycle engine, but is a mixed-cycle engine. The explosion phase of the cycle serves to convey, disseminate and intermix the clouds of vapor through the air.

Explosion is certainly a wave phenomenon, if not in the forced movement at least in the free movement before the restoration of equilibrium. The wave often shown on the indicator diagram is not a record of pressure, for if two or three springs are used in succession, waves of as many periods are recorded, and all agree with the natural period of the indicator motion for the spring in use.

Not only does the explosion appear to be necessary, but the designer must consider the effect of the explosion upon the dissemination of vapor. If, in reacting to explosion, the vapor is forced into contact with cold walls without travel through the air charge, the results will be bad. The vapor cloud may be arrested centrally with some admixture of air and driven radially by the explosion to good advantage. The vapor cloud may be a cone with just enough air in its center to propel it outward through the air by a central explosion with excellent results.

In the solid-injection engine there is no means of producing an oil fog of such perfection as is produced by air injection. The minute drops of oil are not carried in on an energized vehicle, but must by virtue of their own mass and velocity carry from the nozzle to the desired location. In spray action, delivery accurate as to time, duration and velocity is more important than atomization.

Combustion Conditions in Solid-Injection Engine

The combustion-chamber air or wall conditions must be maintained such that inflammation does not take place instantly upon injection. This momentary delay is aided by the incomplete state of compression at the beginning of injection and by the latent heat of vaporization of the fuel. If inflammation of the minute drops were to take place before their vaporization, the smoky flame of a body of oil burning upon the surface would naturally result.

Much inventive ability has been expended upon the artificial production of turbulence in the solid-injection engine. Engines of the Vickers type developed essentially the same economies as those fitted with displacers on the piston, etc. Differentiating the displacement of air through the neck between the cylinder and combustion space proper generally shows very low velocities. Even when the displacer is used, as in the Crossley engine and the Gunther or Deutz-Otto type, the differential of pressure is low.

The development of the solid-injection engine has suffered much by reason of the transmission of honestly proposed but fallacious theories of working. It has suffered, too, by a persistent desire to produce in an essentially individual type the characteristics of the air-injection Diesel. However, no single step in the development is without its contribution to the real theory of its working, and at this hour it would seem that the ultimate types have emerged from a seeming chaos of ideas to stand the test of time and progress.

In the discussion on the paper on the "Solid Injection Engine," Elmer A. Sperry praised the author for the great amount of real information given in the paper.

P. P. Bourne in a written discussion took exception to the statement that the solid-injection engine did not operate on the Diesel cycle. It was thought that the precombustion principle used in a number of engines did give a constant pressure combustion line.

P. H. Schweitzer was unable to agree with the author in his discussion on penetration and expressed the opinion that the oil would not spray over one inch. Turbulence of the air and not spray penetration was the secret of successful combustion.

Economic Status of the Diesel Engine

In a paper discussing the importance of the Diesel as a factor in the reduction of power costs, L. H. Morrison stressed the fact that if central stations would adopt the oil engine the necessity for centralization of power equipment would disappear. Costs, both those of operation and of overhead, were declared to be below those prevailing in steam plants.

The author gave the costs in a large number of the important central stations and stated that operating costs of the oil engine, even though of small power, would be less than those of the steam plants. In view of the longer life of the Diesel it was the author's contention that the overhead charges would be low, making the Diesel plant show the lowest possible total cost per unit of energy generated.

The relation of the oil engine to industrial power plants was touched, data being given to show that first costs are not high and operation satisfactory. Waste heat recovery was gone into and the resultant saving outlined.

In the discussion that followed the reading of the paper, S. A. Hadley in a written discussion took exception to the curve showing costs of Diesel engine installations, which the author in his closure stated was based on actual contracts.

A. Contra expressed the opinion that the maintenance charges of the Diesel were insignificant; quoting the results of two years operation of the William Penn, which is Diesel driven. The speaker outlined his observations of the activities in Europe and stated that the Diesel locomotive was in successful operation in Germany.

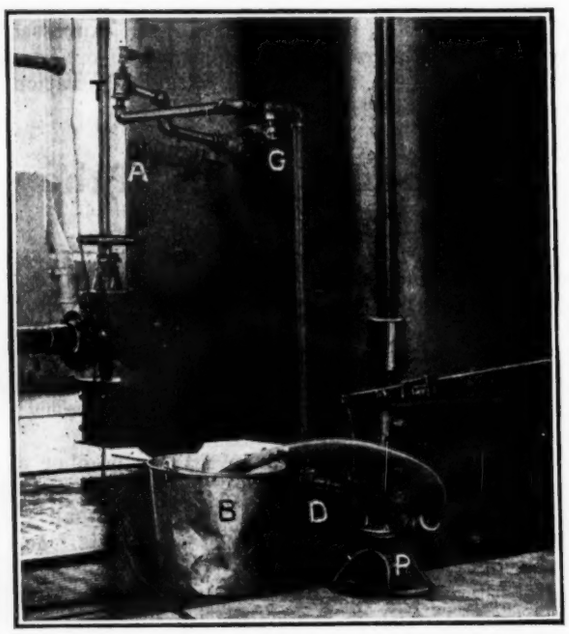
E. H. Trump reported on the new solid-injection engine now driving a Humphrey principle water pump in California. He expressed a great deal of optimism as to the future of the oil engine.

Prof. A. J. Wood of Penn State College felt that more attention should be given to the Diesel locomotive. If the oil engine had the efficiency claimed, its use in place of the steam locomotive would result in a saving of millions of dollars.

Testing Transformer Cooling Coils

By Ralph Brown*

To detect any evidence of a reduction in the dielectric strength of the insulating oil used in water-cooled transformers, samples should be tested monthly. A breakdown test at monthly intervals is sufficient if the transformer cooling coils are kept in good condition, for then the probability of a dangerous amount of water leaking into the oil within any thirty-day period is extremely remote. Although the presence of the slightest amount of moisture is highly undesirable, actual experience with large, high-voltage power transformers indicates that under certain conditions several gallons of water



EQUIPMENT FOR MAKING LEAKAGE TEST

can slowly leak into the tank without materially affecting the insulating qualities of any part of the oil except that at or near the bottom of the tank. If a cooling coil should burst, thereby suddenly discharging considerable water into the tank, a breakdown of the transformer would probably result.

The danger of leaks of any nature occurring in a transformer cooling coil while in service can be almost eliminated by applying a pressure test at intervals of about six months, the exact time being largely dependent on local conditions. For example, cooling coils operated at low pressure and supplied with clean water that does not form scale would be subject to less deterioration than if operated at high pressure with dirty water containing considerable scale-forming impurities. The object of such a pressure test is to determine if the cooling coil is free from leaks.

Before preparing to make a pressure test, the transformer must be taken out of service, since the cooling water must be shut off. After the transformer is cut out and proper precautions have been taken to insure the safety of the workmen, the cooling water must be cut off and the cooling coil drained. If the water will not flow out by gravity, the supply pipe should be disconnected at a union or flanged joint, and compressed air at low pressure used to force the water through the discharge end. After the water has been removed, the discharge pipe should be disconnected from the cooling coil.

The usual method of applying the test pressure is by means of a hand-operated plunger pump, as shown at *P* in the figure. A bucket *B* containing about two gallons of oil is used for the sump to which the pump suction is connected. A tee *T* should be screwed on the supply end of the cooling coil and an accurate pressure gage connected thereto. A globe valve *G* that will be tight when closed should be connected between this tee and the discharge connection at the pump. It is well to connect a second tee and valve to the pump discharge at *D* so that at the completion of the test the oil may be drawn through this valve or forced out at *A* by admitting air through the valve at *D*. After being filtered, the used oil is returned to the storage tanks.

All pipe runs should be made as short and direct as possible, and to be of any value all joints must be tight, thickened shellac making a suitable joint compound. Valve *G* must be absolutely tight when closed.

One method of filling the cooling coil with insulating oil is to use a pipe fitting into which a funnel may be inserted at the discharge end of the coil, and pouring the oil from a bucket until the cooling coil is completely filled. A better method is to use a pump, such as one forming part of the dehydrating outfit commonly installed in modern stations, or oil may be drawn directly from a storage tank by admitting air thereto. The object of filling the cooling coil with insulating oil instead of water is to eliminate the possibility of water becoming mixed with the oil in the tank if the test pressure causes a leak to develop.

With the cooling coil filled with oil and one end *A* capped or plugged, the pump is operated, and the pressure, which should increase with each pressure stroke, is gradually increased until double the maximum working pressure is indicated on the pressure gage. Valve *G* should now be tightly closed, and unless a leak exists or the temperature of the oil surrounding the cooling coil changes, the pressure indicated on the gage should remain unchanged. If, after remaining under pressure for one hour or longer, any change in pressure can be accounted for by a change in the transformer temperature, the cooling coil may be safely considered to be free of leaks.

A pressure test should be made on a cooling coil before a transformer is placed in service and immediately after being cleaned of scale. The pressure at the beginning and end of each test, duration of test and transformer temperature at the beginning and end of each test should be recorded for future reference on printed mimeographed forms.

A solution of soft soap or laundry soap and water fed at stated intervals to the cylinder of an air compressor will clean out the carbon deposits. This solution may be fed through the regular air-cylinder lubricating devices. Of course, after this treatment the interior of the cylinder may rust quickly unless the soap solution is followed up with oil for some time before shutting down. Never, under any circumstances, should kerosene or gasoline be used to clean out an air-compressing cylinder. Its use may easily lead to a disastrous explosion.

*The Great Western Power Company.

Second Power Show a Big Success

Last Year's Pioneer Effort Surpassed in Number and Quality of Exhibits—Remarkable Variety of Working Models and Full-Sized Equipment Shown

THE many thousands of engineers who visited the Grand Central Palace in New York City during the week of Dec. 3 were rewarded by an extraordinary array of exhibits. Last year's "National Exposition of Power and Mechanical Engineering"—the first A.S.M.E held simultaneously. Aside from the number of exhibitors and visitors the show was notable for the quality of its exhibits. Working models (and in some cases full-sized commercial units) of coal-handling equipment, stokers, powdered-fuel systems, water-

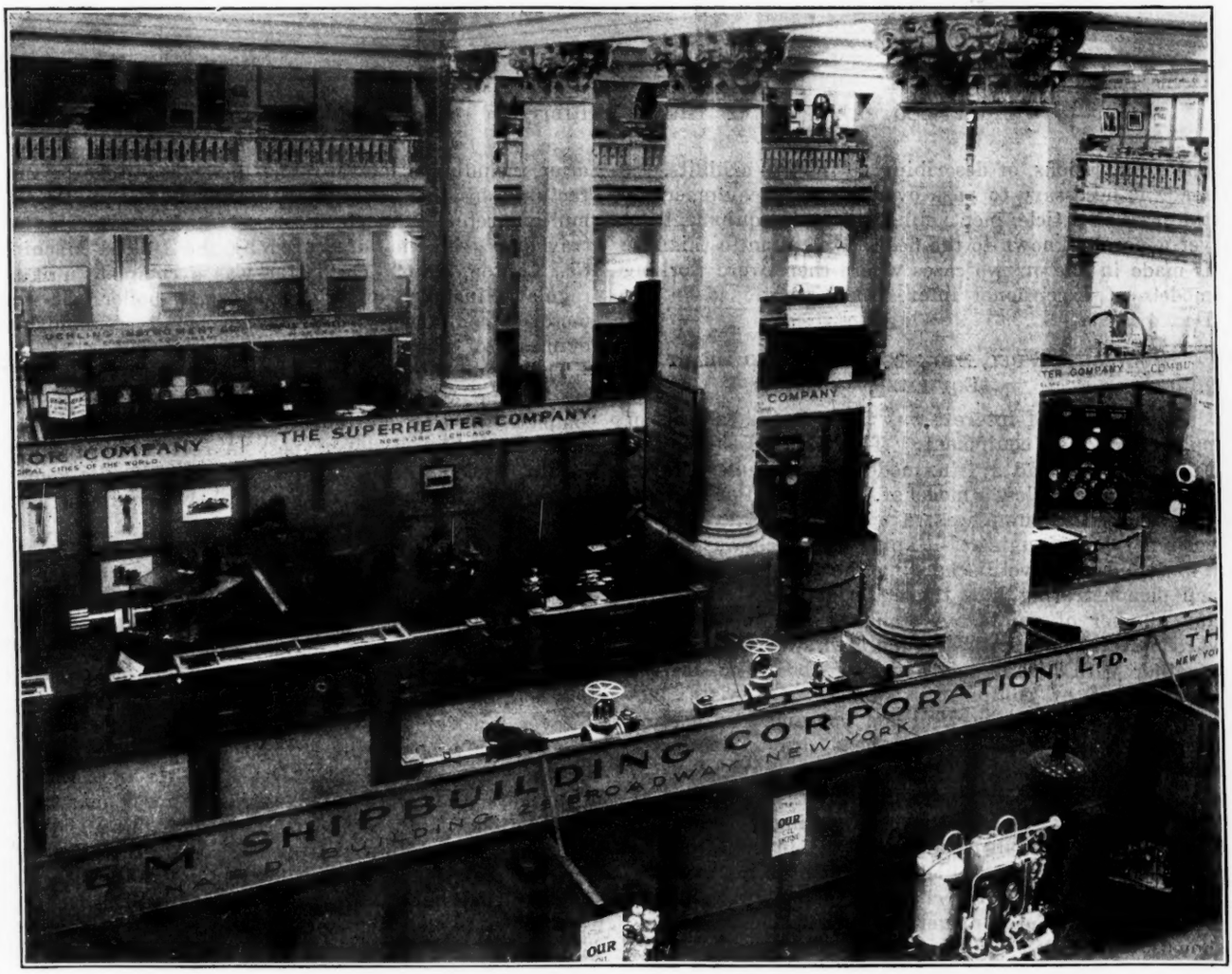


FIG. 1—VIEW OF THE EXPOSITION AS SEEN FROM ONE CORNER OF THE MEZZANINE FLOOR

ever held—was a big success, but this second show has definitely surpassed it both in quantity and quality.

There were 270 exhibitors, more than double the number of last year, so that the entire mezzanine floor, as well as every nook and corner of the main floor, was needed to house exhibits. It seems highly probable that the final record of admissions for the week will greatly exceed the 47,580 that attended last year's show.

In addition to the large number of local engineers and executives, including members of the N.A.S.E. and A.S.M.E., there was a considerable attendance of out-of-town engineers. Many of these had been brought to New York by the double-headed attraction of a National Power Show and the annual meeting of the softening systems and many other things held the interest of visiting engineers. In addition there were movies, special lectures and highly original demonstrations. This show must rank not only as the greatest Power Show, but also as one of the greatest industrial exhibitions ever held in this country. Only the comparative scarcity of prime movers left any gap to be filled. Practically every other branch of mechanical power equipment was represented by numerous examples.

The previous issue of *Power* gave a complete list of exhibitors with their chief products. It also mentioned a few exhibits of particular interest, such as those with working models. The impossibility, within practical

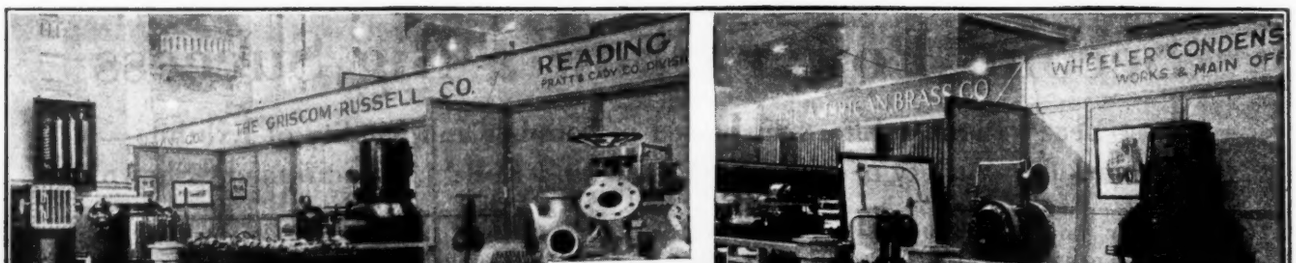


FIG. 2—BOOTHS TYPICAL OF THE 270 EXHIBITS AT THIS YEAR'S POWER SHOW

space limitations, of describing all the 270 exhibits, has made it necessary to pass over standard equipment in the present article, mentioning only new equipment not yet generally known to the field. Exception to this rule is made in one or two cases where there were working models of exceptional interest not mentioned in the Dec. 4 issue.

Pulverized Fuel, Stokers and Forced Draft Equipment

A great deal of interest was taken in the exhibits of pulverized fuel equipment. The Fuller-Lehigh Co., Fullerton, Pa., had a 1-in. model of the Fuller-Kinyon pump mounted below a model of its standard pulverized-fuel bins. The pump was in operation conveying pulverized talc, through a 3-in. pipe on which was placed a distributing valve discharging the fuel to a glass jar and demonstrating how the material is distributed to any number of points. A standard 4-in. distributing valve, electro-pneumatically operated, was also shown, together with bin signals and switchboard to operate these pieces of equipment. Models of the "Fuller-Lehigh" screen mill, vertical and horizontal adjustable burners, and Randolph waste-heat drier, were also shown.

Another exhibit of outstanding interest was that of the International Combustion Engineering Corporation. Here a Raymond pulverizing mill was in operation as was also a two group feeder. A model of the Lopulco furnace wall showing the character of hollow wall construction as applied to pulverized-fuel furnaces was also shown. In addition to these exhibits there was in operation two retorts of the Frederick underfeed stoker, thirty-one tuyeres in length. This stoker was equipped with a new type of secondary ram built up of air admitting tuyeres, also a single dump plate to which air is admitted under control from a wind-box formed by the steel beams that support the rear end of the stoker.

A model of a new type of mechanical oil burner and several types of steam- and gravity-type burners were shown. Two sections of the "C E C" air preheater, as illustrated and described on page 902, Dec. 4, issue, were also included in the exhibit.

The Erie City Iron Works, of Erie, Pa., had a complete pulverizing unit of 2,000 lb. per hour capacity in operation. The Aero unit pulverizer described in the Aug. 28 issue of *Power* was also exhibited.

Several mechanical stokers were shown in actual operation including a lateral-retort underfeed stoker manufactured by the Sanford Riley Stoker Co., a Detroit multiple-retort underfeed stoker and a Harrington traveling grate manufactured by the United Machine Co., Canton, Ohio. The latter was a complete unit as regularly installed under a 3,000-sq.ft. boiler. It was motor-driven, the speed reduction being accomplished by means of silent chain drives.

The Hand Stoker Co., New York City, representing Flynn & Emerich Co., Baltimore, exhibited a complete working section of the Huber Stoker in the standard and heavy-duty types. A recent improvement on this stoker is the application of hydraulic motor drive. The heavy-duty type was shown equipped with overhead hopper and ignition arch.

The Cokal Stoker Co., Chicago, Ill., exhibited hopper feed stokers of the size suitable for installation under a 72-in. by 18-ft. horizontal return-tubular boiler.

The Marion hopper feed stoker described in *Power* for Sept. 4, 1923, was exhibited by the Marion Machine, Foundry & Supply Co., as was also the Type A balanced-head soot blower manufactured by this company.

Several working models of water-tube boilers were in operation showing the circulation within the boiler, the liberation of steam, etc. Other models and sections of headers and tubes were exhibited to demonstrate constructional features and methods of baffling.

A class of exhibits that attracted a great deal of attention was that of oil-burning equipment of both the steam and mechanical atomizing type. Several burners were shown in operation spraying water in a glass case. This made possible the demonstrating of the atomizing properties of the burners. Other types of burners were shown mounted on the boiler front together with the air registers in operating position. Among the other exhibits of oil-burning accessories was that of a combined pumping and heating unit recently developed by the Bethlehem Shipbuilding Co. In this unit two pumps and two coil heaters are interconnected and mounted on one base and form a complete unit, especially adapted for installation in plants where the space for this equipment is limited.

For supplying forced draft on hand-fired or stoker-fired furnaces, several different types of fans were shown by the Coppus Engineering Co. and also the Wing Manufacturing Co. The latter exhibited a new type of turbo-blower the steam end of which is fitted with a two-row rotor, governor and filtered lubrication

system. In addition to this a featherweight unit heater for heating and de-fogging in dyehouses, paper mills, etc., was shown. This unit eliminates the usual duct work required for this purpose. The units are made in floor, ceiling and window types. Another recent development in forced-draft fans was exhibited by the Carling Turbine Blower Co., Worcester, Mass. The blower is made in capacities from 10,000 to 40,000 cu.ft. with static pressure up to 8 in. and the turbine is equipped with self-aligning ball bearings.

The Allen-Sherman-Hoff Co., of Philadelphia, exhibited a sectional cast-iron ash hopper fitted with a new type C power-operated gate. The hopper was equipped with "A-S-H" quenches which were in full operation and demonstrated the ability of the ash gate to collect this water and maintain a dry ash basement. The ash gate is also water-sealed. An additional feature of the exhibit was an ash sluiceway made in sectional cast-iron construction and lined with renewable chilled iron.

Valves and Fittings

There was abundant evidence that valves and fittings may be had for higher temperatures and pressures. Here, steel was the keynote of construction. Motor-controlled valves for remote operation were exhibited in many booths by actual working models in large sizes.

The Techno-Service Corporation presented a globe valve in which the disk was completely withdrawn from the stream of flow when the valve was wide open. This appears in Fig. 3. The disk was swung on a pivoted lever similar to the disk of a check valve. On the complete opening of the valve, the disk is lifted above the path of the fluid.

It will be noted from the picture that an unusually large valve stem is provided. The thread for lifting the valve is contained inside of this stem and the packing around the outside. At the bottom of the stem is placed the crosshead member to which the lifting link is pivoted.

The Henry Vogt Machine Co. showed a forged steel four-inch gate valve. This appears in Fig. 4, and was developed especially for high pressures and temperatures, as encountered in oil refining. It is also adaptable for steam under the same conditions. The piping is connected by flared and ground joints.

The Crane Co. has prepared new lines of cast-steel valves up to 1,350 lb. per sq.in. at the prevailing temperatures. A remote-controlled valve, as in Fig. 5, is equipped for electrical operation.

The Ashton Valve Co. exhibited a master pressure pilot gage, for use in boiler or turbine rooms. This was a double-faced gage, with a scale varying from 185 to 215 lb. A comparatively small variation in steam pressure was therefore easily observed by the movement of the pointer. The Continental Valve & Equipment Co. showed a loose ring union regulator combined with a reducing valve. This has been worked out into a novel compact self-contained unit.

The Chapman Valve Manufacturing Co. is well equipped with valves for higher pressures, as well as a remote-controlled valve with indicator to show whether it is open, closed or geared for hand operation, electrical operation or locked. Photographs of crystal structures for various metals showed their suitability for high temperature operation.

The Edward Valve & Manufacturing Co. has developed a vertical non-return valve for the connection between boilers and headers. A large working model was on exhibition. As a combined stop and check valve it may be operated with the handle underneath when installed horizontally. Valves up to 900-lb. steam pressure are designed. The Everlasting Valve Co. exhibits a shockless pendulum stop valve. This consists of a valve that may be closed by the release of a weighted handle through automatic means. No shock is transmitted when the seat reaches its closed position or open position, whichever function the valve is to have automatically. Shock is prevented by releasing the weighted

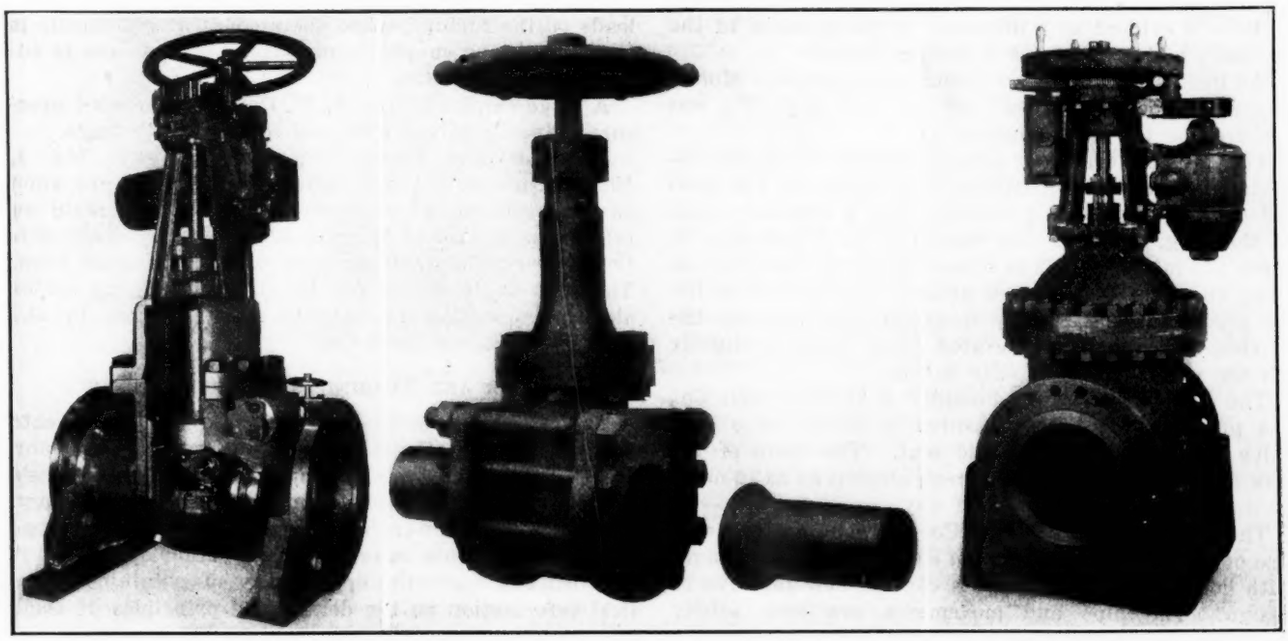


FIG. 3—A STRAIGHTWAY FLOW GLOBE VALVE WITHDRAWS THE DISK ENTIRELY FROM THE FLOW OF STEAM

FIG. 4—A FORGED-STEEL GATE VALVE FOR HIGH TEMPERATURES AND PRESSURES WITH FLARED PIPE JOINTS OF VOGT DESIGN

FIG. 5—HIGH-PRESSURE MOTOR-OPERATED GATE VALVE FOR REMOTE CONTROL, ONE OF CRANE SERIES

lever from connection with the valve disk. This is accomplished by a train of gearing that automatically disconnects at the end of the valve travel.

A "Thru Bonnet Bolt" type of non-return stop valve in an 8-in. size appeared in the booth of the Foster Engineering Co. This is suitable for 800 deg. total temperature, 350 lb. working pressure. The Goetze Gasket & Packing Co. showed an interesting type of valve disk. This is a clever combination of elastic copper with asbestos in between, forming a cushion against which the seat may be closed without injury to itself. The Homestead Valve Manufacturing Co. has developed a protected seat valve operated with a lever and cam. The end of the stem that contacts with the cam is contained in guides so that it represents a crosshead element for taking side thrusts, giving only vertical pressures on the stem.

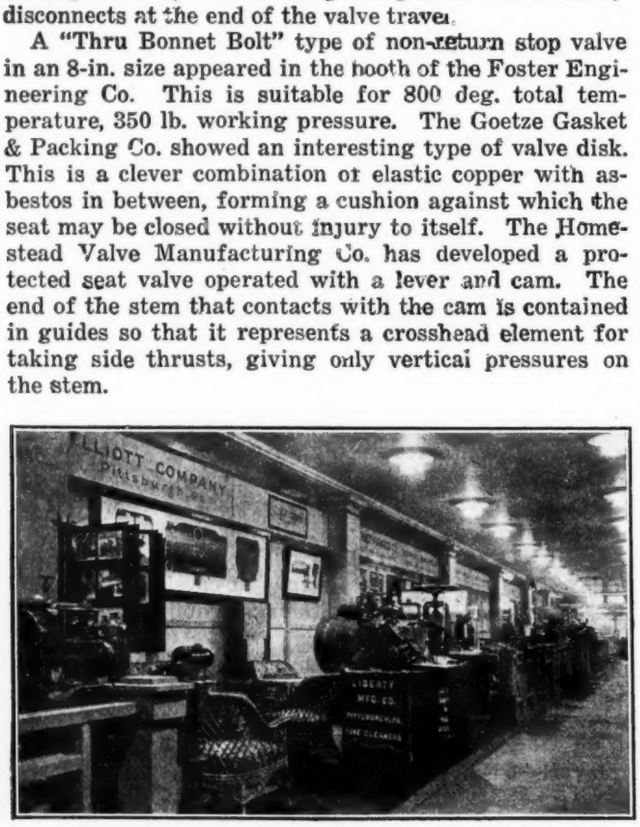


FIG. 6—LOOKING DOWN THE SOUTH AISLE OF THE MEZZANINE

The Jenkins Bros. show an interesting development in rapid-action hydraulic valves. This is primarily for use in laundries. It is normally open, in which position the lever is vertical with the valve installed vertically. In closing the valve, the lever is horizontal and locked. It thus is evident at a distance, by the position of the handle, whether the valve is open or closed.

An inside through union bonnet-type cast-steel Monel-mounted globe valve for 400 lb., 800 deg. F., was featured by the Lunkenheimer Co.

The Merco-Nordstrom plug-type valve developed especially for severe conditions, was shown by the Merrill Co. A lubricant is inserted into a vertical recess in the plug, which is also threaded for a bolt used to force the lubricant. It is forced under the seat and up along the sides by means of grooves. This tends to lift the plug off the seat. By screwing down against the lubricant, pressure is generated which tends to slightly lift the valve making it easy to turn.

The Pittsburgh Valve, Foundry & Construction Co., has prepared for high pressures by means of a gate valve that contains a flexible seat. The seats of the disk are permitted to rock a small amount so as to make up differences of alignment if any.

The Nelson Manufacturing Co. shows an entirely new line of bronze globe valves. In addition, a line of gages with double spring movements contain new features of design. The pipe and movements are both solidly mounted against the gage itself, so that twisting on the gage will not throw any strain on the delicate parts.

The Walworth Manufacturing Co. exhibited the original Stillson wrench. It had evidently seen some severe service. An interesting orifice valve was on exhibition. This represents a reducing valve that may be set for any pressure, and means of measuring the amount of steam discharged. It consists principally of four parts: The reducing valve proper; a receiver which is a large chamber which not only insures a smooth even flow of steam, but also presents conveniences for multiple outlets; the third feature is the nozzle in each outlet, if more than one, and the fourth is the gage which reads the steam discharged in any desired units.

The Lead Lined Iron Pipe Co. displayed fittings and pipes made of iron and lined with lead. Special means were taken to insure tight connections in the threads, so that the liquid would be only subject to a lead path and would not make any contact with the iron of the pipe.

The Payne Dean Co., Ltd., in addition to its remote-controlled valve, has developed an interesting control for steam turbines or other prime movers. The operator in the control room signals with a whistle or bell in the usual way. Orders are then transmitted by means of a dial similar to that for marine service. The engineer answers on a companion dial, indicating that the message had been understood. Also there was a signal system which would give the engineer advance notice of changes of load, in regard to amount and time.

A new development in the Craig system of draft control was an exceptionally sensitive regulator for furnace drafts.

A two-stage pump in which the packing on the shaft at each side is under pressure was in the booth of the Wheeler Condenser & Engineering Co. By admitting the water in the middle of a two-stage pump, discharge pressure is conveyed on the outside of each impeller.

The C. H. Wheeler Manufacturing Co. showed a radojet air pump in which makeup water and condensate were circulated without mixing. Heat is thus transmitteed to the makeup water before it goes to the deaërating apparatus. All the heat contained in the steam used in the radojet is returned to the boilers with an efficiency of approximately 98 per cent. In case of light loads on the turbine, when the amount of condensate is insufficient, the supply from a cold-water source is admitted automatically.

A large exhibit of the A. W. Cash Co. included pressure-reducing valves with self-contained strainers.

A furnace door latch as described in *Power*, May 1, 1923, for preventing the opening of furnace doors when an explosion or other abnormal conditions create an internal pressure, is designed along lines radically different from the familiar type of furnace door latch. There is no tendency for the latch to fly up under abnormal conditions. A model was exhibited by the De Waters Safety Latch Co.

Boiler and Turbine-Room Instruments

The exhibits of boiler- and turbine-room instruments were especially attractive and instructive. In many cases instrument boards composed of several panels and equipped with the different types of indicating and recording meters were displayed. As a large number of the instruments were shown in actual operation, it afforded engineers the opportunity of obtaining practical information on the details and principles of their operation.

Among the recent development or improvements made in this class of apparatus is the redesigning of the Hays CO_2 Recorder (see Fig. 7) exhibited by Paul

B. Huyette Co., Inc., Philadelphia. Some of the features of this instrument are as follows: The gas trapped for analysis is placed absolutely at atmospheric pressure and is maintained at a constant temperature throughout the analysis. The size of the sample measured is 50 c.c., thus conserving the caustic potash. One charge of caustic is sufficient to operate the recorder for four months without renewal, and the reading indicates closely the actual conditions existing in the furnace, as there is but one minute lag to forty feet of pipe.

Another recent development exhibited by the Bristol Co., Waterbury, Conn., is the Bristol-Derr boiler level indicator and recorder for indicating and recording variations in the water level in a boiler under pressure. It consists of a Bristol recording pyrometer and operates on the thermoelectric principle, making use of a series of cold junctions which operate in proportion to the height of water in a cylinder connected in parallel with the water column on the boiler. The indicator is placed at any convenient height above the boiler-room floor. Another feature of the exhibit was a Bristol-Fuller valve especially adapted to controlling the temperature in oil-fired furnaces.

A new departure in pressure-regulating valves was exhibited by Boig & Hill, Inc., representing the Julian D'Este Co., Boston, Mass. The new regulator is of the auxiliary operated type, having a secondary or

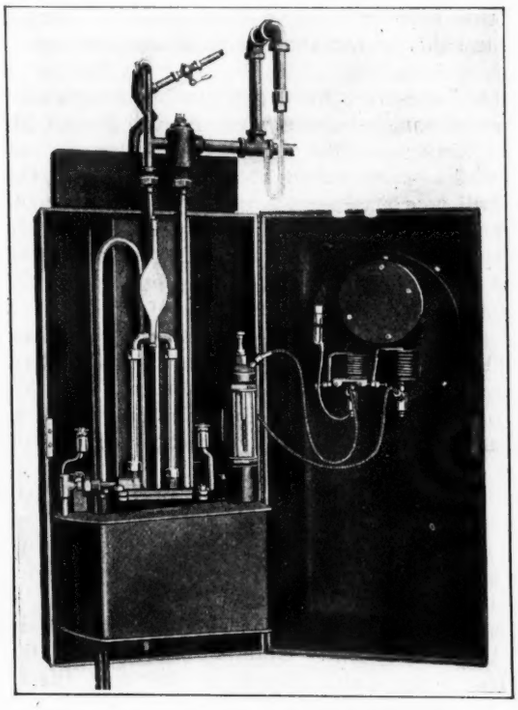


FIG. 7—CO_2 AND DRAFT RECORDER

pilot valve operating and controlling the main valve. The main valve is single-seated and spring-loaded and is operated by a piston.

A new type of rotary, valveless, vacuum pump designed especially for heating systems, paper mills and general wet vacuum pump service was shown by the Frederick Iron & Steel Co. This pump will be illustrated and described in an early issue of *Power*.

The Falk-Bibby flexible coupling as shown in Fig. 8 was exhibited in operation on a motor-driven centrifugal pump operating at 1,700 r.p.m. The inner end of the motor was pivoted at a point directly below the coupling, and the outer end was made to oscillate constantly through an arc of 5 to 10 deg. The coupling consists of two flanged steel disks (one keyed to each shaft), a tempered-steel spring in segments forming a continuous cylindrical grid, and a shell. On the outside of the flanges are pitched cross-grooves in which the spring is placed. The spring is the flexible member,

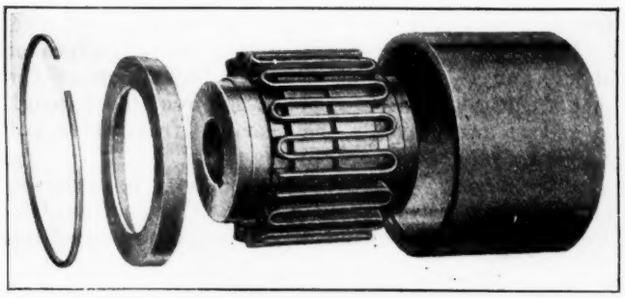


FIG. 8—FLEXIBLE COUPLING DISASSEMBLED

and its shape and that of the grooves form the characteristic features of the coupling.

An exhibit of special interest to boiler-room attendants was the National water column illuminator (see Fig. 9) manufactured by the National Co., Boston, Mass., and exhibited by W. K. Sowdon, New York City. The gage glass is illuminated by two directed light sources and the reflection of the directed light beam by the meniscus at the water level. These two features make the water level visible from all parts of the operating aisle. The lens is made sufficiently strong to withstand the disruptive force of an exploding gage glass. Provision is made, by a series of openings in the lamp housing, to direct a stream of air over the lens, thus preventing the accumulation of dust.

The Power Specialty Co. exhibited the latest improvement in its radiant type superheater, showing especially the new all-steel construction with cast-steel elements. A special point was made of the two-stage combination convection and radiant-heat-type superheaters.

A new electric gas analysis recorder was exhibited by Charles Engelhard, Inc. This instrument, which utilizes the principle of thermal conductivity by electrically heating two standard resistance wires, one in a standard gas and the other in the gas to be analyzed, gives a record on a strip chart along with the record of flue-gas temperature. A more complete description will be given in a later issue. In the same exhibit was shown an engineers' test set combining thermometers for temperatures below 1,300 deg. F. and thermoelectric pyrometers for higher temperatures.

A water column designed for high pressure was shown by the Williams Gage Co., Pittsburgh, Pa. The columns are made of cast steel with walls $\frac{3}{4}$ in. thick. All trimmings are fitted with Monel metal valves and seats.

The Roto Co., Hartford, Conn., exhibited its new type of synchronized swing frame head tube cleaner designed to eliminate wear on the tube and insure the cutter's working only on the scale. An additional attachment shown by this company was an operating valve with a renewable seat. The valve is opened or closed by a slight rotation of a knurled nut. It is inserted between the rear end of the cutter and the

hose connection. These attachments will be described more fully in a later issue.

A new departure in the line of bearings was the cutless bearing shown by the B. F. Goodrich Rubber Co. This bearing is especially adapted for service under water, or where water containing grit, sand or other cutting material is pumped. The bearing consists of an outer casing of steel, bronze, or other metal, depending upon the service for which it is to be used. To this outer casing is vulcanized a soft "Olivite" rubber surface which is finally ground to the required size. A spiral groove is then cut on the inner surface of rubber, and it is claimed that by the action of the shaft a constant stream of water is circulated through the groove and prevents the bearings from being cut by grit or sand contained in the water.

An outstanding exhibit in gasoline engine-driven equipment was that of the Climax Engineering Co., Clinton, Iowa. It included a six-cylinder gasoline

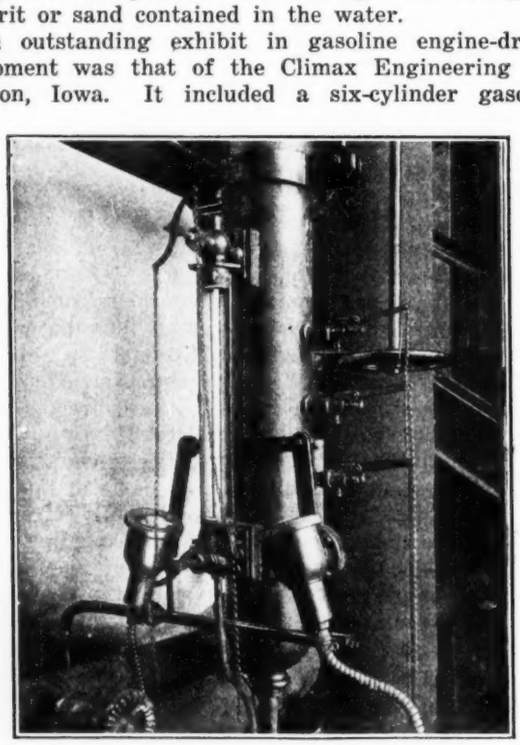


FIG. 9—TYPICAL INSTALLATION OF GAGE GLASS ILLUMINATOR

engine direct connected to a 75-kw. alternating-current generator; two four-cylinder engines and three models of refrigerating machines.

Exhibits of Refractories

The field of refractories was well represented by exhibits of firebrick, special blocks, monolithic wall materials, etc. The Waite and Davey Co., Inc., showed an air cooled side wall and flat arch as described in the May 15 issue.

A new air-setting high-temperature cement, made without silicate of soda, was exhibited by the Celite Products Co. The same company displayed sample firedoors with insulating refractory material molded in the cup-shaped inner faces.

A combination of Drake Block with a supporting side-wall tuyere was shown by the Drake Non-Clinkering Furnace Block Co. Air entering the tuyere divides, part going directly to the fire and part to the block. The 45-deg. bevel of the tuyere keeps the hot fuel from contact with the furnace blocks.

The Furnace Engineering Co. showed an actual pulverizer of only two pounds per hour capacity. The design is substantially the same as that of the new 8,000-lb.-per-hour Simplex Unit Pulverizer made by the same company. Another exhibit of this company was the Type X "A" bar, which employs lateral spacing to insure air distribution with resulting liberal cooling.

In its exhibit of furnace walls and suspended arches the American Arch Co. showed a new filler piece for curved ends of arches to reduce the number of hangers needed. This was described in the Aug. 21 issue.

The Bernitz Furnace Appliance Co. showed the application of Bernitz Super Blocks to traveling-grate stokers, a single row of these blocks being applied on each side for about two-thirds the length of the grate.

The Maphite Corporation gave examples of the applications of the natural mineral refractory, Maphite, which was described in the Jan. 2 issue.

An improved method of forming refractory surfaces by the spraying or "gun" process was shown by the Quigley Furnace Specialties Co., Inc.

The King Refractories Co. announced the marketing of a new high-temperature cement "Plastikdo" for laying up firebrick and patching and for the construction of monolithic walls.

A relatively new line of crushing and mixing machines was exhibited by the S. Obermayer Co. These machines, whose principal use in the power field is for crushing up old firebrick and forming the mixture for monolithic furnace walls, operate with a rolling action which is said to coat the grains more thoroughly than hand mixing.

The McLeod-Henry Co. exhibited veneer wall lining and the flat suspended arch described in *Power*, May 22.

The Keystone Refractories Co. gave advance notice of a new insulating brick known as Key-Cel-Brix which will be placed on the market early in 1924.

Air-cooled side walls and flat arches, as described in the May 15 issue, were shown by Waite and Davey Co.

Sections of furnace walls, arches, etc., were exhibited by most of the aforementioned refractory manufacturers as well as by the Jointless Fire Brick Co., Liptak Fire Brick Arch Co., and the Flint Fire Brick Co.

In connection with its gas producers for power and other purposes the Smith Gas Engineering Company had literature describing a new mechanical feeding and poking device.

As a modification in the design of its steam-jet ash conveyor, the M. H. Detrick Co. showed a multijet steam box designed to give greater capacity than a single jet for the same steam consumption and to reduce the wear on the conveyor elbow.

Although the Hagan Deconcentrator is several years old, it has been recently modified and incorporated in a system of boiler-water treatment shown in the exhibit of the Hagan Corporation. This will be described in a later issue.

The Elliott Co. had blueprints of a new type of deaerator designed to operate without temperature drop. It consists essentially of two tray-type open heaters in series, one above the other.

The Standard Water Systems of New Jersey announced a new two-compartment oil heater designed to permit operating either half while the other is undergoing cleaning or repair.

The Constantator, a new electrically operated device to regulate stoker speed and fan speed or damper, was exhibited by the Dempsey Furnace Co.

EDITORIALS

F. R. LOW, EDITOR

Access to Plant Costs

AS THE pace quickens in the pursuit of operating efficiency in power plants, knowledge of costs becomes of increasing importance to the operating engineer. For many years the value of comprehensive information about the physical performance of a plant has been appreciated by owners and executives, but in many cases little thought has been given by the engineer's superiors to the benefits associated with cost data sharing. Many steps can be taken toward better operation through analyses of fuel consumption per unit of output, through studies of labor requirements, the use of water, supplies, records of repairs, etc., but unless the operating man responsible for plant efficiency knows regularly and completely what the installation is doing in dollars and cents, he is bound to be hobbled in his administration.

The interchange of operating data, and of costs for that matter, is becoming more and more common for private comparison. There is a disposition also among power producers to share cost information to a much greater extent than of old. But whether physical data or costs are interchanged or not, in particular plants inside of their own organizations engineers cannot be expected to produce the best results without full economic information. Log sheets are good as far as they go, but modern power-plant economics demands far more of directing engineers than the interpretation of these records of daily runs.

Water Power in Maine

RENEWED activity in Maine political circles, coupled with the rapid spread of popular interest in superpower development in the East, brings the non-exportation of power policy of the Pine Tree State again into the foreground of public discussion. For some years water-power development has been made the football of politics in Maine. Conservation of stream flow by the construction of adequate reservoirs has been held back by differences of opinion over the question of state development versus private development under commission regulation, and sentiment against allowing the exportation of surplus water power in the form of electrical energy has blocked interconnection between Maine and large power systems outside the state. The possibility of transmitted power from the St. Lawrence River or from Quebec coming into central New England carries with it some prospect of Maine's development being economically short-circuited unless a change from the isolation policy takes place in the not distant future.

To the engineering mind it is a grave mistake to treat such problems as these as primarily political issues. Of course legislation is involved in such developments, but the issues are not in themselves political. They are economic. The facts are ascertainable upon which sound decisions as to policy can be made. The potential and developed water-power resources of Maine are well known. The markets available are pretty well understood. It seems clear enough that far more power is latent in the streams of Maine than the industries of the state are likely to require for many years. The popular idea is that Maine would suffer from power exportation and that by keeping such development and use at home, industries will be drawn to the state because of their inability to secure cheap enough electricity elsewhere. In a recent address at Bangor, Clarence G. Stetson, formerly associated with Secretary Hoover in conservation work, set forth the fallacies of this conception and sounded the only clear note of warning to Maine that has been heard for some time as to the dangers of the power-isolation policy.

If the people of Maine will consent to the exportation of surplus power through efficiently designed, built and operated interconnections with the rest of the Northeastern States, it should prove a great boon to themselves and to their neighbors. Based upon thorough engineering investigation, interstate interconnection should be shared by Maine in the coming years, the ultimate goal of all such activities being merely the production, transmission and distribution of power at the lowest reasonable cost to all concerned.

Reducing Auxiliary Power

IN HIS paper last year on "The Commercial Economy of High Pressure and High Superheat in the Central Station" George Orrok stated it should be possible to save nearly four thousand B.t.u. per kilowatt-hour by a reduction to the lowest limit of the heat losses which we know exist in our present installations. One of the principal sources of such losses is in auxiliary power demands.

Where is it possible in a large power station to reduce auxiliary power? This question must be considered from two angles: First, in reference to the plant now in operation, and second, in the designs of new stations.

Many of the present stations were laid out for steam-driven auxiliaries and have given fairly good operating results with such equipment. It probably would not be considered desirable to change these auxiliaries to motor drive, and hence improvements in performance must be looked for in the operation of the units themselves. There may be certain cases where changes in equipment will be warranted in view of the savings possible. Frequently, it is possible to reduce the quantity of circulating water to the condensers at times and thereby save power in pumping. If these pumps are steam driven, a reduction in speed may accomplish the desired result. Often an additional pump is kept in operation when not absolutely necessary. Boiler-feed pumps are frequent offenders in this respect. Conveyors and crushers are left running idle. Lights are left on when not needed. Leaky valves and traps and dirty heaters are also sources of loss. Every power-plant engineer will find many places in his plant where small savings

of auxiliary power can be made which in the aggregate will result in a material reduction in his demands for station service.

The designer of a new station has a heavy responsibility in regard to the power demands of auxiliaries. He must decide from economic data whether steam or electrically driven auxiliaries will be used, if electrical, whether direct or alternating current, and whether constant- or variable-speed motors shall be installed. It has become common practice to put variable-speed motors on circulating, condensate and boiler-feed pumps, on forced- and induced-draft fans and on stoker drives. If steam-driven auxiliaries are used, then the exhaust conditions of these units must be so chosen that the best use is made of the steam from the viewpoint of heat balance. This in some cases may mean that these units may operate at a partial vacuum. Bleeding turbines to heat the feed water reduces the steam to the condenser and thus tends to reduce the condenser auxiliary power demand. Hence, this is a desirable feature in many cases and should be adopted when possible. Lighting should be carefully studied so that no excess power is used for station lighting. Crushing and conveying systems should be considered to find which has the least power demand combined with ruggedness and reliability.

Another important factor is the selection of units of high efficiency for auxiliary service. Frequently, an engineer is tempted to purchase cheaper units at lower efficiency. Careful calculations will generally indicate that this is false economy. In design, therefore, the careful selection of high-efficiency units will assist materially in reducing auxiliary power demands.

Selecting the Correct Lubricant Versus Improving the Service Requirements

THE fitness of the lubricant for the machine is a subject of wide interest. With high-speed machinery the question has been accentuated. Undue heating, sludging or foaming are familiar results of improper selection.

Recent investigation has served to bring out more strongly that oxidation may result from undue exposure of oil to air, and to point out the ill effects of water. The two conditions tend to cause rapid deterioration. Tests indicate that the qualities of a lubricant make a great difference in the length of service under such adverse conditions. This fact is well known in practice.

In view of the cost of lubricating oil and the possible expense of service tests, it appears that the effort which would be expended in adapting the lubricant to radical conditions might often be put to better advantage elsewhere. Why subject oil to excessively high temperatures if they can be avoided or reduced? Why should water find its way into a lubricating system? In prime-mover operation today, foresight and prevention are required rather than that sort of maintenance work related to repairs and expensive, laborious attention.

In order to insure reasonable life of the lubricant, a number of points should be considered, such as temperature of supplied oil, pressure, speed in the pipes, contact with air, prevention of water, introduction of acids or other impurities and variations in pressure. In addition, reconditioning, including removal of sludge, water and impurities, should be carefully worked out.

It is surprising what single expediencies in some instances may greatly improve operation. The prevention of steam or water is seldom absolutely practicable, Very often a special shield may change a bad condition into one of satisfaction. Water in reasonable quantities may often be separated by a simple plan of settling. By piping to the lowest point of the oil system convenient for oil removal, water and sludge may often be drawn out to a large extent, after a night's shutdown of the unit. Other conditions may be improved by a practical treatment, such as the introduction of a cooling coil to a self-cooled system under adverse circumstances. Plans for reconditioning or removal involving special apparatus, may produce satisfactory operation at a more reasonable cost.

Small Units for Light Loads

A WHOLESOME tendency in power-plant design is seen in the inclination of a number of operating companies in the central-station field to purchase occasional smaller units than the station average for light-load service. The growth of the electric light and power industry is enormous, but there are still some deep valleys in the load curves of many companies on Sundays, holidays and during the later night and early morning hours. The cost of starting a large turbo-generator for upper peak service only is substantial in many instances, and there seems to be a real field for much smaller equipment, notwithstanding its relatively poor economy at full load when compared with the full or three-quarter load efficiencies of the big units.

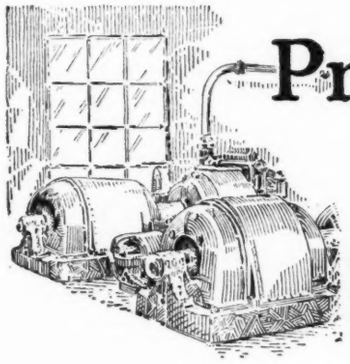
The use of the terms "large" and "small," is of course, relative, but in one plant the recent purchase of a 10,000-kva. unit to operate on light loads in a station with several 20,000-kva. units carries out the thought, and in another a 2,500-kva. unit going into a plant with two or three 10,000- or 15,000 kva. units "fills the bill." Nothing short of a careful analysis of load conditions, efficiencies and costs warrants the conclusion that in uniform size lies economic salvation.

Shale Oil Developments

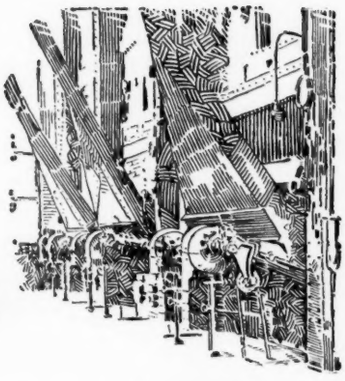
THE development of the shale-oil industry is apparently on more stable grounds than heretofore. The earlier estimates of the cost of mining and retorting were so high as to hinder the erection of refineries until petroleum oil reached three or four dollars a barrel. Mining and refining experts now claim that the total cost will not exceed one dollar and thirty cents a barrel, immediately placing shale oil in a competitive position with petroleum oil.

Several refineries are in the course of construction, while one, a Virginia retort, is in commercial operation. It is undoubtedly true that shale oil cannot compete at tidewater points or in the Midcontinental or California fields, but there is every reason to expect local consumption close to the Colorado and Kentucky shale beds to absorb the near-future output. The present success in handling shale, although still on a small basis, argues favorably as to the future supply of liquid fuel even after the exhaustion of the petroleum fields.

Judging from the papers and discussion at the A.S.M.E. session on heat cycles and high pressures, stage feed heating and electrically driven auxiliaries are definitely established. Reheating, air preheating and pressures up to one thousand pounds have made out a good case on paper, but have still to win general acceptance by actual demonstration of lowered power costs under operating conditions.



Practical Ideas *from* Practical Men



Management and Mismanagement of Steam Boilers

Much has been written in textbooks and technical magazines regarding the care and management of steam power-plant machinery, and the ground seems to have been fairly well covered. It is proposed in this article to mention a few irregularities common to many small plants, which, if corrected, will go far toward maintaining a condition of efficiency and economy in the plant.

An old maxim says, "Eternal vigilance is the price of safety." In steam plants it is also the price of economy. As the duties of the erecting engineer call him to various steam plants, he has opportunities to observe the operation of many kinds of equipment, and being a trained mechanic, he is likely to notice irregularities that might escape the eye of the casual observer. He may notice the apparent indifference of the small, isolated-plant owner to the care of what may be considered the most important adjunct to the plant, the steam boiler.

The boiler once purchased and installed, he may detail for its attendant some handy man or jack-of-all-trades, and feel assured that with the water carried at a certain height in the glass and plenty of coal shoveled into the furnace, the desired steam-pressure will be maintained indefinitely. He then turns his mind to other matters, and if any failure occurs to the boiler, the blame is generally put on the manufacturer.

Now a careless or incompetent fireman can do or leave undone many things that will shorten the life of a boiler. Some men, while firing will stop to light their pipe or talk with someone, heedless of the cold air that is being admitted to the furnace through the open door, cooling the plates and causing unequal expansion of the metal; and if this is persisted in, leaks in seams and tube ends are bound to occur. In one case the fireman would always open both furnace doors when working at the fires. On being asked why he did that, he answered that he wanted more light on the coal pile. Such a man will fire too heavily, so that he may have a longer time to sit down. He will allow ashes to accumulate in the ashpit, which is likely to cause the grates to warp and burn. He will punch viciously with a pointed slice bar at the side walls, trying to remove the clinker, thereby loosening the brickwork and destroying the furnace lining. The careless man will open a supply valve quickly, causing water hammer and perhaps rupturing the pipe and fittings. He will needlessly use a monkey wrench in closing a valve, thus straining the valve seat or twisting the stem. If he blows the tubes with steam, he will not take the trouble to drain the pipe line, thereby allowing wet steam to blow through the tubes. He will allow leaky valve stems on top of boilers to drip and the water to run down inside the covering, thereby grooving the outside of the shell.

There are many ways in which an intelligent boiler attendant, who is interested in his job, may increase the efficiency of the plant. He will not only take pride in keeping the boiler and its accessories clean and in order, but he will always strive to better his own record in economical coal consumption.

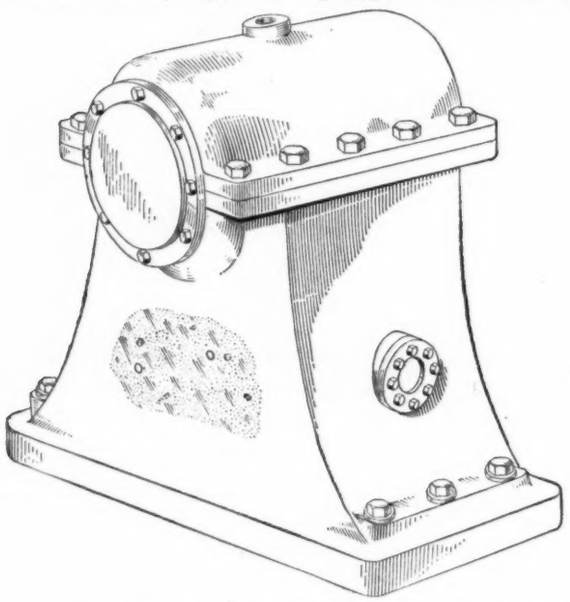
No hissing steam leaks on valve stems or pipe joints will be heard. The water will be carried at the proper height. A glance in the furnace will show a bright, clean fire, indicating that the proper draft is being maintained and that the fire is giving the maximum amount of heat. No noisy, clattering feed pumps will disturb the quiet of the boiler room, because they will be kept packed and the lost motion taken up as it occurs. There will be no loss of hot water from leaky blowoff valves, as the valves will be used and tested regularly. A suitable place will be provided for the tools used in the boiler room, and they will always be kept there. No unsightly rubbish will be thrown on the coal pile, and all unused firebrick and other material will be piled neatly in some inconspicuous place. It is a pleasure to work amid such surroundings. Some plant owners are averse to paying for overtime, and a boiler attendant who is not particularly interested in his work will be loath to spend his Sundays washing out boilers. This is a job that is essential, as it gives the opportunity of inspecting the interior of the shell and drum, braces, tubes, seams and rivets for pitting and corrosion. In localities not subject to boiler ordinances some boilers are opened once a year only, for insurance inspection. In one plant of this kind, a 72-in. by 18-ft. boiler carrying 120 lb. steam pressure was found to be priming badly and water was blowing from the stem of every steam valve in the mill. The insurance inspector found that the feed pipe had rusted off at a coupling a short distance inside the front head, allowing the rest of the pipe to fall on the tubes. Instead of the water being carried to the coolest part of the boiler, it was discharged directly into the steam space. The inspector also found the rear head banked up with mud and scale six inches deep, the result of using river water without filtering. Too much care cannot be used in guarding against corrosion, and when detected, steps should at once be taken to arrest it. There are too many causes for corrosion to be enumerated in this article, but with most waters a liberal treatment of soda has been found effective. When pitting is discovered, the spot should be thoroughly cleaned and the pits filled with zinc oxide or portland cement to stop corrosion. Air and gases

like carbon dioxide and sulphur dioxide mixed with the feed-water are corrosive agents and should be passed through an open heater with a vent to the atmosphere, to allow the gas to escape. Closed heaters should not be employed where there is air and gas in the feed water, as they are likely to collect gas and there is danger of corrosion. When boilers are to be left empty, they should be given a coat of graphite and oil and all valves closed tight to keep the boiler dry. All ashes and soot should be removed from the furnace, tubes and shell, and a circulation of air maintained, to prevent an accumulation of moisture on the metal.

Utica, N. Y. M. M. BROWN.

Stopping Oil Leaks in a Porous Casting

A prime mover that had recently been installed, began to leak oil in an undesirable manner around one of the pillow blocks. Several sand holes were located, which were then drilled, tapped and plugged. It was found,



POROUS PORTION OF CASTING WAS WELL CLEANED AND THEN PAINTED WITH SHELLAC AND GRAPHITE

however, that when in operation, the plugged holes were oiltight, but nevertheless an appreciable amount of oil appeared to leak through the cast iron over a considerable area, as indicated by the shaded portion on the side of the pillow block in the figure. Upon examining more closely, it was found that the casting had a porous spot at this place of considerable magnitude.

There were no facilities at hand for welding over the face of the casting. Besides, it is doubtful if the leaks could have been satisfactorily stopped in this manner, and there was considerable risk of causing undesirable strain in the casting by such a method. A rather novel way was worked up for stopping this leak, which proved to be entirely satisfactory.

As shellac tends to melt or boil at a comparatively low temperature, it was thought that this could be utilized in stopping the pores of the metal. The face of the porous spot was carefully scraped and sandpapered. The oil was removed from the oil cellar in the pillow block. The porous spot was then carefully dried off with a blow-torch so that oil no longer tended to seep out. The porous area was also carefully cleaned with wood alcohol, so that all traces of oil were entirely removed from the face.

Some well-mixed orange shellac and powdered graphite was prepared, and a flat paint brush was obtained for applying the mixture to the bearing.

The leaky spot was then warmed with a blow-torch until it reached a temperature where shellac would be hardened immediately upon contact. The surface was painted over several times with the shellac and graphite. After this had cooled to normal temperature the oil was replaced and the machine put in service, and no signs of an oil leak has since appeared at this point.

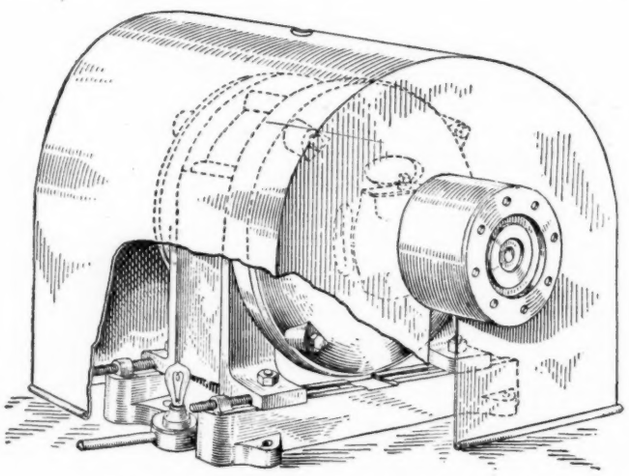
It should be noted that the usual flake graphite would not be suitable for such a purpose. It is necessary to use the finest ground graphite, which is especially prepared of flour-like consistency. G. F. WHITE.

New Castle, Pa.

Keeping Motor Dry in Cold-Storage Building

What can be done with a small amount of heat toward keeping a motor dry in a damp place is shown by the following experience:

The motor was in use in the air-conditioning room of a large cold-storage plant. At certain intervals it was used to drive a fan to circulate the air from the cold-storage rooms through calcium chloride to remove the moisture. The rest of the time the motor was stand-



LAMP USED TO KEEP MOISTURE OUT OF MOTOR WINDINGS

ing idle and collected a great deal of moisture on its winding, which promised to give trouble, as the insulation resistance was becoming low. The motor could be removed and baked periodically, but this not only involved considerable work but also much inconvenience, due to the motor's being out of service.

The problem of keeping it dry was easily solved by placing a metal housing over it and installing a 75-watt lamp inside, as in the figure. When the lamp was first lighted, the temperature around the motor was 36 deg. F. and after one-half hour this increased to 60 deg. Since the installation of the lamp no trouble has been experienced with moisture on the motor. The housing was vented at the top to allow the escape of any moisture that might get under the cover.

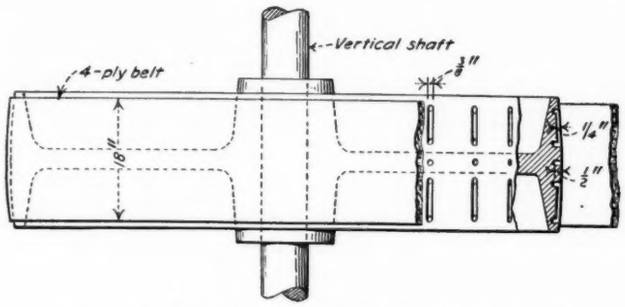
Montreal, Canada. WILLIAM BUSH.

Comments from Readers

Grooving the Pulley to Prevent Belt Slippage

Referring to the articles by O. Petterson in the Oct. 9 issue and by L. W. Loweree in the Nov. 13 issue, in which they discuss the relative merits of holes and grooves in the face of pulleys as a means of preventing belt slippage, I had a similar experience some time ago, and the method I used to overcome the trouble may be of interest.

At the plant where I was formerly employed, the power was supplied by a 100-hp. Corliss engine, belted to a lineshaft. This shaft carried a 6-ft. diameter pulley that was belted by means of an 18-in. four-ply belt to a 6-ft. pulley on a vertical shaft that extended from the basement to the eighth floor. Frequently, in damp



HOW THE PULLEY WAS GROOVED TO PREVENT BELT COMING OFF

weather or if the boiler blew off, the moisture would get on the belt and it would come off the pulley on the vertical shaft.

The trouble was finally overcome by drilling and grooving the pulley as shown in the illustration.

Five rows of holes $\frac{3}{8}$ in. in diameter and $\frac{1}{2}$ in. deep were drilled around the face of the pulley, and a groove was then cut between the two outside holes, as shown. The grooves were made approximately $\frac{3}{8}$ in. wide. and $\frac{1}{4}$ in. deep. This completely eliminated the trouble.

North Hackensack, N. J. H. LAWRANCE.

Lubricating Oils For Internal-Combustion Engines

There has been much discussion of the relative qualities of lubricating oils made from asphalt or paraffin-base crudes, for use in the power cylinders of internal-combustion engines. A great deal has been said on both sides by the supporters of each. It seems that many of the points at issue could be agreed upon if due consideration were given to the work the lubricant is called upon to do.

A prominent authority has stated that the three essential requirements of a good motor oil are: It must lubricate the piston efficiently at the temperature encountered in the cylinder; it must give a good seal to the piston and rings; and it must burn without forming carbon deposits in the cylinder.

Viscosity of all mineral oils decreases with increased temperature; also, the heavier the oil the higher the coefficient of friction. While in some instances the oils refined from paraffin crude, of low and medium viscosity, retain their body better upon a rise in temperature, the asphaltic oils can be refined to higher viscosities in a straight-run product. Paraffin oils of high viscosity must be blended or compounded.

The deciding factor of viscosity is ring seal. If the rings fit tight, a light oil will give good results; if they are badly worn, a heavier oil is made necessary. Now in dealing with viscosity, the kinematic viscosity and not the true viscosity, has been considered. For example, take two oils, one from each crude, of the same viscosity expressed in Saybolt universal. The heavier of the two, referring to the one having the highest specific gravity, really is the more viscous because, being heavier, or higher in specific gravity, it naturally flows from the viscosimeter orifice more rapidly than it would if it were lighter, or had lower specific gravity. As the asphaltic oils are higher in specific gravity than the paraffin, they leave the instrument more rapidly, so the real or absolute viscosity is about 5 per cent higher than the Saybolt instrument would indicate, when comparison is made with a paraffin-base oil.

On account of the low carbon deposit from the asphaltic oil little trouble is encountered by rings being stuck in their grooves. There is no wax to gather and bind the small atoms of carbon freed from the oil as distillation takes place, to be cooked and carbonized later. Then again, when the higher-viscosity oils are necessary, owing to excessive wear, the asphaltic or straight-run oils distill without decomposition, and they have a better spread value, which enables them to work in behind the rings and puts the burden of ring seal on the rings themselves, which is as it should be.

There is a distinct advantage in favor of the asphalt-base oil, because of the nature of the carbon formed by the two oils. The carbon from the asphaltic oil is loose and flaky in nature and easily blows out of the motor on the exhaust, or scavenge stroke of the engine. It does not remain in the cylinder to stick the rings in their grooves or deposit in the combustion space to be later carried through by the piston during the operation of the engine. Even if the carbon from the asphalt base was picked up by the piston, it would be found to be soft like soot and would not score the cylinder walls.

Nothing has been mentioned about the usual topics of discussion by the oil salesman, such as gravity, color, flash, fire test and cold point.

Running over these topics briefly, we find that gravity is of little use, except to determine the source of crude supply. Color has been given entirely too much discussion in the past. Modern refiners do not aim at bright pale colors. Some of the lower-viscosity oils

naturally refine to bright pale colors, but this is no indication of purity. Some refiners think that such colors are pleasing to the eye and refine their motor oils to meet their customers' viewpoint.

Flash and fire points are closely related, but wholly inadequate in determining quality as long as the flash point of the oil is 300 deg. F. or above. It would then be entirely high enough for use in internal-combustion engine cylinders.

Flash means little, because it is not expressed in percentages. For instance, an oil may flash at 300 deg. F. and only ½ of 1 per cent of its volume be lost, while a so-called higher flash-point oil may lose 1 or 2 per cent at a slightly higher temperature.

Cold test, while not a requisite of quality, is certainly to be considered as a measure of suitability. Consider two engines, alike in every respect, one inside of a warm engine room the other outside, exposed to cold air currents and low temperatures. The low-cold-test oil from asphalt-base crude is desired for the outside engine. It will flow with the first stroke of the engine. Low-cold-test oils from a paraffin base can be obtained only by complete removal of all the wax, and this is both expensive and burdensome to the refiner.

Houston, Tex. R. J. STEWART.

Overheating of Oil-Engine Piston

The statement of H. F. Shepherd in the Oct. 23 issue, that "possibly the most foolish proposal is that of the cooling the piston and wristpin by passing the scavenging air through the piston," cannot be allowed to pass unchallenged.

The crude piston deflector shown in the article under discussion looks like a relic of the distant past. Perhaps Mr. Shepherd will recognize the design of a piston deflector, shown in the illustration, which is air cooled and which replaced one that was too thick. The new piston had a head ⅜ in. thick and ribbed to make heat transfer effective by forcing all the scavenging air past and in contact with the inner end of the piston. This was to obtain a reduction of piston temperature and to permit the use of higher compression pressures. Piston lubrication, of course, was better owing to the value of a cooled piston as against a red-hot one.

The transfer of piston heat to the charge of mixture takes place just prior to its entry to the combustion space, and in a way the piston head performs the function of a hotspot without the detrimental result due to added heat, as in the case of an automobile engine where the volumetric filling is impaired by reason of the action of a hotspot. As to the value of a piston that is internally cooled, the volume of the clearance space used was 19 per cent as against 22.5 per cent with the same piston design but no circulation of either air or mixture through it.

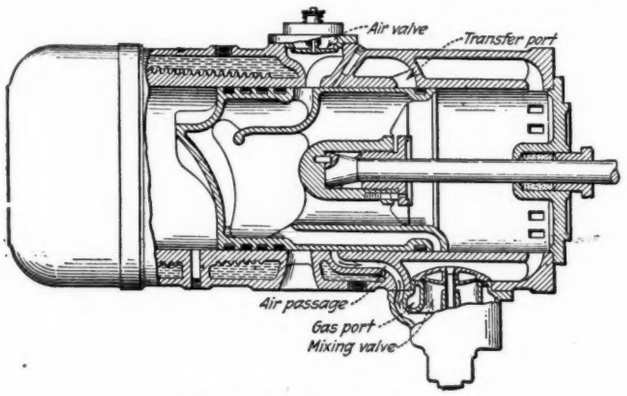
Heat that can be eliminated and utilized results in economy by eliminating the hottest zone in the combustion space and directing the charge against the nose of a spark plug, and so compression pressures can be higher.

Heat that is otherwise lost is regenerated, but it must be done after the volume is completed and before its transfer. Hot blast in a blast furnace is heat regenerated, while the volume of oxygen entering is based on the volume leaving the blowing engine, but the volume is greater than the capacity of a piston.

In other words, I prefer to use a gas instead of a vapor. There is only this difference. Mr. Shepherd prefers to cool the piston on the top side, while I prefer to cool the piston skirt and wristpin and deliver the total charge where it will produce the best results and incidentally aid piston lubrication due to a cooled piston.

The Krupp Works have patents on the cooling of both piston and cylinder heads as a means for increasing the transfer of combustion heat. Krupp, however, does not advocate the addition of metal to aid heat absorption, nor does anyone else who pretends to be alive to the value of reducing the weight of an engine piston and all that is attached to it.

There is a single exception as to that point for, as Dr. Walter Rosenhain has pointed out, the cooling effect of aluminum-alloy pistons makes it possible to increase the compression ratios of engines without risk of preignition, thus producing a very marked increase in power, running in some cases up to something like 20 per cent, and at the same time effecting a decrease



HOTSPOT PISTON DESIGN

in fuel consumption per horsepower. Heat conductivity, not weight, is the prime advantage.

It is quite evident that if there is any loss due to late exhaust-port closure or exhaust-port inertia, the air that enters first will be lost through the port. It is a reasonable conclusion that the last part of the mixture must be the purest, and this part is delivered on the lip of the piston back of the deflector where the exhaust inertia or any other influence can have no effect on it after the transfer port closes. This mixture is then carried up and is located in the spark-plug area.

It is good practice to operate an engine at the highest compression pressure consistent with the ability to keep the piston cool enough to lubricate and carry a reasonable overload for a reasonable time. An overload causes a hot piston and the result is preignition and, if continued, will wreck the best-designed engine. Weight in a piston will not eliminate heat any more than a sponge will eliminate water; both absorb while the former will assimilate heat and dissipate it to the piston and all attached to it.

If the addition of heat to the scavenging air is foolish it is evidently in line with modern thought. The Cummings Syndicate, Ltd., Glasgow, Scotland, advocate the use of exhaust gases to raise the temperature of the scavenging air to 165 deg. F. in a Diesel engine and with a result as to weights that seems revolutionary.

Cleveland, Ohio. JAMES MCINTOSH.

Prevent fires by keeping polishing and dusting cloths and oil mops in metal containers.

Easy Lessons in Engineering

Water at Rest

The science dealing with the mechanical action of water at rest is called *hydrostatics*, *hydro* meaning "water" and *statics* meaning "at rest." So the term "hydrostatic pressure" means the pressure of water at rest, or more generally, that of any fluid at rest.

The laws of water and other fluids in motion are given in the science of hydraulics. The present article

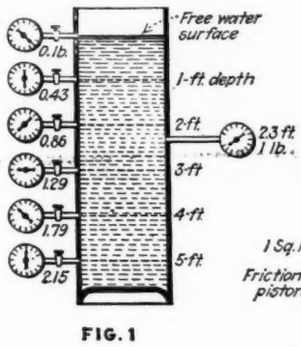


FIG. 1

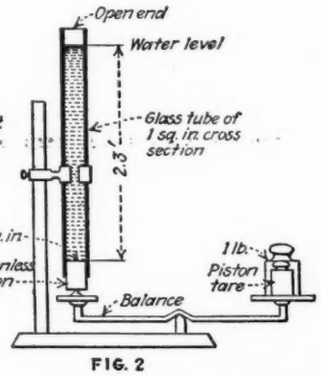


FIG. 2

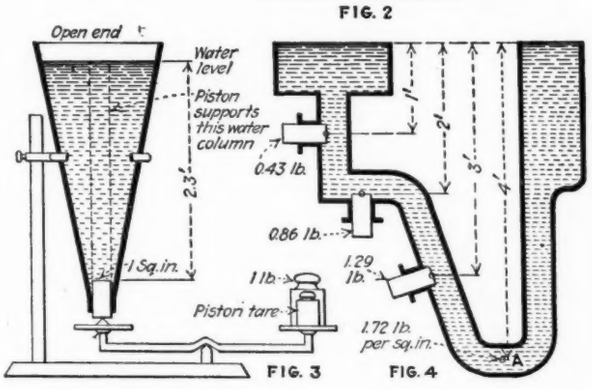


FIG. 3 FIG. 4

FIGS. 1 TO 4—LAW OF HYDROSTATIC PRESSURE

Fig. 1—Pressure increases 0.43 lb. per sq.in. for each foot of depth or "head." Fig. 2—Proof of law for the simplest case. Fig. 3—Shape of container makes no difference. Fig. 4—Pressure at a given point is the same in all directions.

will deal entirely with water at rest, leaving the study of water in motion for another article.

First, consider the case of water at rest in a tank or reservoir, as shown in Fig. 1. It will be found that the pressure at any depth is that at the surface plus 0.43 lb. per sq.in. for each foot of submergence. The shape of the reservoir makes no difference. Conversely the pressure increases one pound per square inch for each 2.3 ft. of depth.

This can easily be seen to be true by the example shown in Fig. 2. Here an open-end glass tube, with a cross-sectional area of one square inch, is filled with water to a depth of 2.3 ft. At the bottom is a frictionless piston resting on one arm of a balance. On the other is a weight to balance the weight or "tare" of the piston and another to balance the pressure of the water column. The sides of the tube, being vertical, can carry none of the weight. The tube contains $2.3 \times 12 = 27.6$ cu.in. of water. One cubic foot of water weighs 62.5 lb., so one cubic inch weighs $62.5 \div 1{,}728 = 0.0362$ lb., and the 27.6 cu.in. $27.6 \times 0.0362 = 1$ lb. Therefore the total weight carried by the piston is one pound.

Since the piston area is one square inch, the pressure must be one pound per square inch. For the same depth of water and shape of tube, if the area were 5 sq.in., the *total* force on the piston would be 5 lb., which would still be 1 lb. per square inch.

This proves the law for a vertical cylindrical tank but not for other shapes. It will be found, however, to hold for any shape. For example, Fig. 3 is like Fig. 2 in every respect except that the glass container is shaped like an inverted cone. It might seem that in this case the force on the piston would be greater than one pound per square inch, because the total weight of the water present is much more than in Fig. 2. Yet the pressure will be exactly the same as before. The reason is that the walls, being inclined, now carry part of the weight. The piston carries only the weight of the dotted cylinder of water straight above it. If the glass container were suspended from a spring balance, the balance would read the total weight of the container and water minus the one pound carried by the piston.

Not only does the shape of the container make no difference, but the pressure is the same in all directions for a given depth. If the piston were horizontal or tipped at any angle, the pressure per square inch would still be the weight of a vertical column of water one square inch in cross-section and of a height equal to the submergence of the center of the piston face beneath the free surface of the water.

For example, in Fig. 4 if each of the pistons has a cross-sectional area of one square inch and is submerged the amount shown, the end pressures on the pistons will be as shown. It will be noticed that this pressure depends only on the depth. The shape of the containing vessel and the direction of the pistons make no difference.

This explains why water "seeks its own level." To understand this, consider the point *A* in the bottom leg connecting the two vertical branches of Fig. 4. The pressure at *A* may be considered as due to the 4 ft. of head on the left branch. It must then be 1.72 lb. per sq.in. The head on the right branch must also be 4 ft., in order to produce a balancing pressure of 1.72 lb. per sq.in.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Power Required for Centrifugal To Replace Duplex Circulating Pumps

Water of a hot-water heating system is circulated at 50 lb. by four duplex pumps, three of which are 12x10x18-in., and one pump is 14x12x18-in. Each pump makes 50 r.p.m. What quantity of water is handled, and what number of horsepower would be required to deliver the same quantity of water with a centrifugal pump driven by an electric motor? W. G. A.

The water piston displacement of three 12x10x18-in. duplex pumps running 50 r.p.m. would be

$$\frac{10 \times 10 \times 0.7854 \times 18 \times 4 \times 50}{231} \times 3 = 3{,}672 \textit{ gal. per min.}$$

and of one 14x12x18-in. pump would be

$$\frac{12 \times 12 \times 0.7854 \times 18 \times 4 \times 50}{231} = 1{,}762.6 \textit{ gal per min.}$$

and for the four pumps the total discharge would be 5,434.6 gal. per min.

Allowing 5 per cent for slippage the actual delivery would be 95 per cent of 5,434.6 = 5,163 gal. per min. The water horsepower for delivery of this quantity of water per minute against 50 lb. pressure would be (5,163 × 231 × 50) ÷ (12 × 33,000) = 150 water hp., and with a centrifugal pump of 80 per cent efficiency the actual power required by the pump would be 150 ÷ 0.80 = 187.5 hp.

A variable speed would require the use of a direct-current motor with field or armature speed control; or with an alternating current, a brush shifting or a wound-rotor type of motor could be used. Allowing 90 per cent efficiency of the motor, the maximum electrical input would be 187.5 ÷ 0.90 = 208.33 electric hp. or 208.33 × 0.746 = 155.4 kw.

Utilization of Discharged Diesel-Engine Cooling Water

We have a water-supply system using 7,500 gal. of water an hour which is the maximum capacity of our well pump. Recently, we installed a 440-hp. Diesel engine that requires 2,000 gal. of cooling water an hour. As our pump is operated to capacity, we have to buy this 2,000 gal. To dispose of this water is a problem, as we have no facilities for a cooling tower nor are we allowed to discharge it into the village sewer. What would be the objection if this 2,000 gal. of cooling water, which has a temperature of 110 deg. F., was discharged into our water supply system? By so doing we would have to pump only 5,500 gal. from our well, which would relieve our pump of 2,000 gal. an hour. Also, what would be the average temperature of this water when running twenty-four hours a day? The water from the pump, which is 7,500 gal. an hour has a temperature of 65 deg. F. and the jacket water of 2,000 gals. per hour has a temperature of 110 deg. F. This general supply is used only for lavatory and electrotyping-foundry purposes. Our drinking-water supply is from another source. L. B.

In 5,500 gal. of water at 65 deg. F. and 2,000 gal. of water at 110 deg. F., there is the same amount of heat as would be contained by 5,500 + 2,000 = 7,500 gal. of water at 65 deg. F., and in addition, enough heat to raise 2,000 gal. of water through (110 — 65) = 45 deg. F. or one gallon through 2,000 × 45 = 90,000 deg., or the total 7,500 gal. through 90,000 ÷ 7,500 = 12 deg. Hence the temperature of the mixture would be 65 + 12 = 77 deg. F. Expressed arithmetically, Temperature of the mixture = 65 deg. F. + $\frac{2{,}000(110 - 65) \text{ deg. F.}}{5{,}500 + 2{,}000}$, which is reducible to the simple form,

$$\frac{5{,}500 \times 65 \text{ deg. F} + 2{,}000 \times 110 \text{ deg. F.}}{5{,}500 + 2{,}000} = 77 \text{ deg. F.}$$

Considered on a heat-unit basis, the gain of heat by the 5,500 gal. of water at the initial temperature of 65 deg. F. would be equal to the loss of heat by the 2,000 gal. at the initial temperature 110 deg. F. Calling x the final temperature of the mixture and allowing that the weight of water at the various temperatures considered is 8⅓ lb. per gal., the gain by the 5,500 gal. would be 8⅓ × 5,500 (x — 65) B.t.u., and the equal loss of heat by the 2,000 gal. would be 8⅓ × 5,500 (110 — x). Then as 8⅓ × 5,500(x — 65) B.t.u. = 8⅓ × 5,500 (110 — x) B.t.u., x = 77 deg. F.

Of course, this final temperature of the mixture remains true only if the hot and cold water are brought together in the uniform proportion of 2,000 gal. of hot to 5,500 gal. of the colder water. There would be no disadvantage, as the supply is not connected with the drinking water and there appears to be no disadvantage in increasing the temperature of the house supply to 77 deg. F., since less heat would be required for hot-water supplies, and the scheme would save the cost of pumping 2,000 gal. of water an hour.

Use of Safety Valve for Reduced Pressure

The pop safety valve on our boiler is set to blow off at 135 lb. pressure, and the inspector informs us that the pressure must be lowered to 125 lb. Is it necessary to provide a new spring in the safety valve to make the change of 10 lb. pressure? M. D.

Ordinarily, the manufacturers provide safety valves with springs that can be adjusted for proper operation of the valve for 10 per cent more or less than the

normal pressure for which the valve is ordered. Hence, if the present spring was furnished for 135 lb., it may be adjusted for 125 lb. However, if the normal capacity ordered for the present spring was in excess of 138 lb., a new spring and new spindle and washers, or necessary mountings, would be required.

It should be borne in mind that a larger discharge aperture of safety valve is required for discharging steam at lower pressure when generated with the same boiler and furnace capacity. Greater discharge capacity of the safety valve can be obtained by greater lift of the valve, and that can be obtained by increasing the amount of blowdown which, for 125 lb. pop pressure, should not exceed 6 lb. The manufacturers of the valve should be able to state whether sufficient discharge capacity would be obtained with more than 6 lb. blowdown, using the present valve with adjustment of the present spring, or whether a new spring would be required, or whether the changed conditions would require a new safety valve.

Changing Speed of Direct-Current Motors

We have a 7½-hp. 230-volt 975-r.p.m. direct-current motor that is operating at 2,000 r.p.m., somebody having changed the shunt winding of the fields. Knowing the size of wire in the present fields and ohms resistance, is there any rule we may use that will help us to make field coils that will reduce the speed 50 per cent? Are there any tables in use that show what current and ohms resistance are necessary to use with shunt fields for various horsepowers and speeds, to control the speed of shunt-wound motors? W. H. K.

The only way that you can obtain the correct size of wire for the shunt-field coils for the motor is to write to the manufacturers and give them the name-plate date. If you wish to change the speed of the motor, this will have to be done by changing the armature winding and not the field winding. If you wish to reduce the speed 50 per cent, it will be necessary to reconnect the winding so as to get double the number of turns in series or rewind the coil with double the number of turns. For example, if the machine has four poles and has a parallel connected armature winding—that is, a four-circuit winding—if that winding is changed to a series connection or a two-circuit winding, the motor will operate at one-half the speed obtained with the four-circuit winding. If this cannot be done, it will be necessary to rewind the coils with double the number of turns of wire one-half the size now in the coils. Reducing the speed 50 per cent will also reduce the output of the motor 50 per cent. You say the machine is now rated at 7½ hp. 2,000 r.p.m.; if the speed is reduced to 1,000 r.p.m., the motor will be good for only 3¾ hp. In making the change in the armature to reduce the speed, no change is made in the shunt-field winding.

Overhead Heating Coils

Is it not preferable from a heating viewpoint to have heating coils of a three- or four-story mill placed along the sides under the windows, rather than overhead; and, roughly speaking, how much more heating surface is required with pipes overhead? D. W. R.

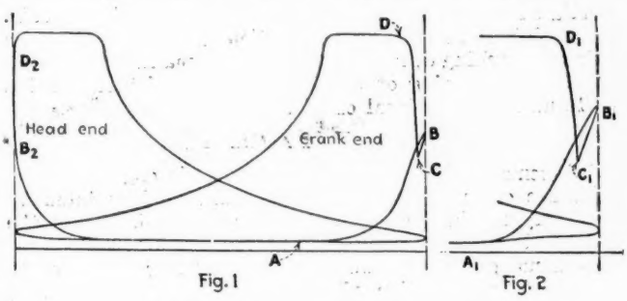
Heating surfaces placed along the walls under windows are preferable, because they induce circulation of the coldest air of the room over the coils and thereby more heat is transmitted per square foot of radiation and all parts of a room are more uniformly heated. When heating coils are placed overhead, circulation of the air is principally confined to the space above the coils, until after the temperature of the air above and near the coils has been raised much in excess of the desired room temperature.

Unless the floor is warmed, as by ceiling coils of the story below, the temperature of air near the floor will be uncomfortably cool to occupants of the room when the air three or more feet above the floor will be overheated. With ceilings of moderate height the direct radiation of heat upon the heads of room occupants, with low temperature of air nearer the floor, is another objection to overhead coils, but this objection can be overcome by suspending screens of wood, or other poor conductors of heat, about two feet below the coils. With overhead heating coils poor circulation of the atmosphere is improved by presence of shafting or other moving machinery and can be largely overcome by having large revolving fans near the coils. For heating rooms of ordinary width and height of ceilings, and without assistance of mechanical ventilation or warming of the floor from a lower story, 10 to 25 per cent more coil surface is required for a comfortable temperature three to six feet above the floor than when the coils are placed along outside walls.

Loop in Indicator Diagrams Due to Late Admission

The pair of diagrams submitted (Fig. 1) are taken from a 30x60-in. Corliss engine. What causes the loop *BC* in the crank-end diagram, and what is the remedy? W. V. T.

The loop *BC* in the crank-end diagram is due to late opening of the steam-admission valve of that end of the cylinder. Closure of the exhaust and beginning of



LOOP DUE TO LATE ADMISSION

compression is at *A* in Fig. 1, as illustrated in the sketch at A_1, Fig. 2, and compression continues to *B* as illustrated by A_1B_1, Fig. 2. Then in the beginning of the return stroke re-expansion of the compressed steam takes place with some loss of pressure from *B* to *C*, Fig. 1, as illustrated by B_1C_1, Fig. 2, when the steam valve finally opens at *C*, with late admission and rising pressure from *C* to *D* in the beginning of admission as illustrated by C_1D_1, Fig. 2. To remedy the defect, adjust the length of the valve rod that connects the wristplate with the steam-admission valve arm of the crank end, so the lead will be sufficient to obtain a vertical admission line like B_2D_2 of the head-end diagram.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Effects Produced by Vibrations in Internal-Combustion Engines

By Dr. J. GEIGER

THE operation of internal-combustion engines is frequently a source of considerable annoyance to surrounding properties, this usually asserting itself in the form of smoking exhaust, noise and vibration. The first two conditions are seldom present in well-designed and properly operated engines, and in any event they can be remedied at little cost. Vibrations are, however, not so easily overcome. They may be due to numerous causes such as unbalanced inertia effects of reciprocating parts, which in turn may produce unbalanced moments that are further complicated by the periodic variations in the reaction of the turning moment of the crankpin, knocks in

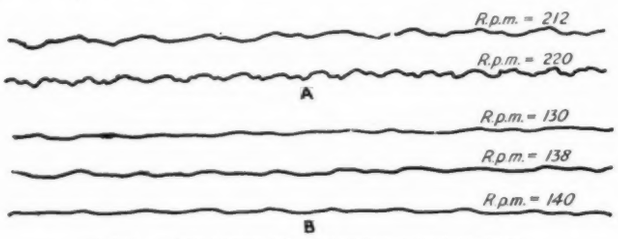


FIG. 1—GRAPHS OF ENGINE VIBRATION

pistons and crankpins, inertia of auxiliaries such as the air compressor, unbalanced rotating parts, and by the critical speed of the crankshaft.

With few exceptions unbalanced inertia effects of reciprocating parts are the principal causes. Vibrations are seldom produced by unbalanced moments, except on board ship, where also disturbances are frequently caused by inertia effects in the air compressor and by critical speeds.

Complaints of annoying vibration usually come from adjacent dwelling owners. Here vibration makes its presence known by quivering of doors, shaking of pictures on the wall and in other visual or audible ways.

Vibrations Felt a Mile Away

It is remarkable that vibrations present in engine foundations are often propagated over a mile. Their intensity may vary in the different directions, depending upon the geological nature of the ground, quicksand, moor land, loose sand, gravel and filled-in ground being favorable to the distant propagation of vibration. Intervening canals, rivers or ditches dampen the effect but little, but the height of the ground water appears to have a considerable influence as has frozen ground.

Vibration affects both houses and people. The residents often assert that cracks in building walls are caused or enlarged by vibration, but this has never been proved. Investigation and measurements have failed to show any danger to ordinary masonry in fair condition, though it may be present in poorly constructed buildings. Plaster-of-paris strips spanning the cracks failed to break or even crack after being in place for a long time.

It is extremely doubtful that vibration exerts a disturbing influence on the nervous system of a healthy person, as the severity of the vibration is less than that noticeable in staterooms on board a ship or that caused by the passing of a heavy motor truck. It is possible, however, that vibration may disturb those who suffer from insomnia and those who are burdened with a super-sensitive nervous system.

A study has been made upon the sensibility to continuous vibration by the average person. Vibrations with an amplitude of 0.003 in. and a frequency of 130 to 400, such as are frequently observed in reciprocating engines, are prohibition in dwellings. An amplitude of 0.0015 in. may still be objectionable but only a very sensitive person can feel the presence of vibration when the amplitude is as low as 0.001 in.

It may be natural to assume that increased frequency would cause greater annoyance, but it has been observed that the effect of a frequency of 360 is but little more than that when the frequency is only 180. Likewise there appears to be a critical frequency which is most easily detected. Quivering of leaves or other visual signs may also add their influence on the imagination.

It is impossible to state the permissible intensity of vibration, since this depends largely upon the character of buildings affected. Vibration that would be perfectly permissible in a factory would be prohibitive in a hospital.

Two graphs taken at the same spot on an oil-engine foundation with the engine running at 212 and 220 r.p.m., respectively, are shown in Fig. 1 at *A*. The engine was balanced. The critical speed corresponded to 220 r.p.m. as is evident from the diagram which is plainly influenced by this condition.

Fig. 1 *B* shows the graphs of the horizontal vibration that occurred in the cellar of a neighboring house with an engine running at 130, 138 and 140 r.p.m. which was located about 900 ft. away. The amplitude of the vibrations was 0.0006 in. at 130 r.p.m., 0.0012 in. at 138 r.p.m. and .0016 in. at 140 r.p.m.

Fig. 2 shows the graphs taken directly on the foundation of an engine, the immediately adjacent floor and in a neighboring house. The frequency of the vibration in the house is considerably greater than those near the engine itself.

As in all cases prevention is better than cure, it is advisable not to install engines that cause vibration in the vicinity of residences. This is particularly true with regard to engines with unbalanced reciprocating parts, more so

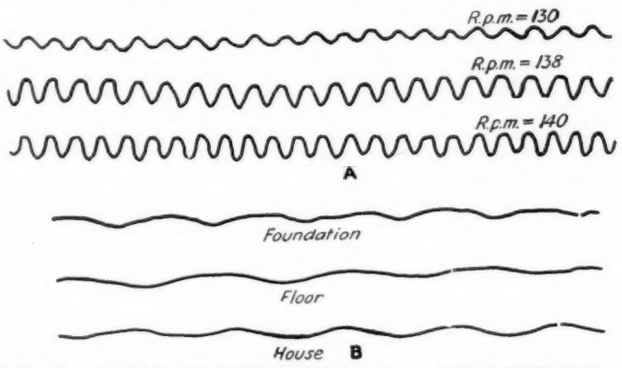


FIG. 2—EFFECT OF VIBRATION ON ADJACENT BUILDINGS

if the engines are horizontal. Experience has shown that the latter type causes more serious trouble than the vertical, because the inertia effect will send forth vibrations that may be almost imperceptible in the cellar of a house, but are magnified to a considerable degree when they reach the roof. Vertical inertia effect can also cause horizontal vibration, but this is generally true only when the intervening ground consists of quicksand or moor.

In one instance a vertical four-cylinder Diesel engine with cranks set at 180 degrees produced objectionable vibration. If a three, five or six-cylinder engine had been substituted or a four-cylinder engine with cranks set 90 deg. to balance the inertia effect had been installed, there would have been no trouble to report.

Manufacturers of engines will not always guarantee that there will be no objectionable effect of vibration. Purchasers should therefore never buy an engine with un-

[3]Extract of paper read before the Diesel Section of the German V. D. I., Berlin, June 29, 1923.

balanced inertia effect on account of the lower initial cost, if the engine is to be operated in the vicinity of residential buildings. It is true, however, that objectionable vibration does not necessarily occur with all such engines. There are many instances on record where no vibration appeared. In fact, a condition of resonance must be simultaneously present. This means that the natural frequency of the house must coincide with the periodic changes in the inertia effect.

For example, a house situated only a short distance away from a horizontal engine and directly in line with the horizontal inertia effect did not show any objectionable horizontal vibration and only slight vertical vibration. In another house, situated at right angles to the direction of the inertia effect and about 400 ft. away, annoying vibration, which increased from the cellar toward the roof, was observed. The frequency of this vibration was just twice the number of engine revolutions, which showed that they did not originate from the relatively great inertia forces of the first order, which varied periodically with each revolution, but corresponded to the one-fifth as great inertia forces of the second order that changed twice with every revolution by the engine. The first house was comparatively long and low and had a natural frequency that was well above that produced by the engine at even twice its normal speed. The second house was comparatively narrow and also was one story higher.

To determine whether resonance is present, it is only necessary to measure the frequency at the different engine speeds. If, for instance, it is discovered that if the frequency between 140 and 160 r.p.m. is proportional to the square of the engine revolutions, and increases or decreases at this rate, no resonance is present. If, on the other hand, the increase is more rapid or if the frequency attains a maximum at a certain engine speed, resonance is sure to be present.

It may be added that annoying vibrations are generally produced when resonance exists. Only in cases of extra-large inertia effect and unfavorable ground conditions has objectionable vibration been observed without resonance.

Preventive Measures That Have Proven To Be Successful

To take preventive measures against resonance would require the knowledge of the natural frequency of all houses that are likely to be affected. The latter cannot be calculated and must be determined experimentally, which would consume much time and involve considerable expense. For practical purposes, only a few rules may be observed in general; that is, low houses occupying a relatively wide area have a high frequency, while towers, chimneys, etc., have a low frequency. Both types are, therefore, not subject to resonance effects. The types of houses that are most likely to suffer from resonance are detached ones, two or three stories high and occupying a small ground area. Blocks of houses with common partition walls are less subject to resonance. It requires considerable experience to estimate properly the natural frequency of houses with any acceptable degree of accuracy.

If circumstances make it necessary to install an engine with unbalanced inertia effects, these can be at least partly neutralized by adding counterweights. For vertical engines only the rotating parts need be perfectly counterbalanced. For horizontal engines the reciprocating parts must also be counterbalanced. This procedure converts the horizontal inertial effect into the vertical, which is less harmful.

It is important to erect engines with unbalanced inertia effects on foundations resting upon bedrock, sand or hard gravel and at some distance from residential buildings. When ground conditions are unfavorable, piles should be driven to solid bearing. When horizontal vibration is likely, these piles should be inclined to take up thrust which will prevent the foundation from vibrating in a horizontal plane.

Enlarging the foundations will not decrease vibration transmitted to surrounding properties. It will only reduce the vibration at the foundation. Another vital point is to make sure that the transmission of vibration to other buildings is not enhanced by masonry, floor beams, etc. The engine-room building should preferably be detached and the engine foundation must be isolated from the side walls.

The use of mats for absorbing vibration and deadening noise has been successful only in the case of small machines such as sewing machines, presses, planers, etc. They have not been satisfactory when applied to large foundations.

An experimental plant was operated at the Augsburg plant of the Mannhein-Nuernberg-Augsburg Co. (MAN) for testing the relative values of isolating mats. Horizontal inertia effects produced by a steam engine reacted on the foundation, but repeated measurements failed to show reduced vibration outside of the foundation. In theory, on account of the high natural frequency of the foundation, such isolation is of little value. These mats are, however, not without virtue, inasmuch as they keep the ground water away from the foundation, deaden noise and are at least evidence to complaining neighbors that the owners of the engine have gone to some expense to minimize the trouble.

As mentioned before, the digging of canals between the engine room and the surrounding property has little or no effect on the vibration produced. Similarly, enlarging the foundation will not lead to improvement, unless this is accompanied by deepening it to solid soils, a very expensive procedure.

A radical cure is to remove the engine to another location. A better and more practical plan, possible with some multi-cylinder engines is to alter the crank setting by installing a new shaft. For instance, if the cranks of a four-cylinder engine are set at 90 deg. instead of the customary 180 deg., the unbalanced inertia effects can be overcome entirely. This of course produces several new movements, but these will scarcely prove to be harmful. If the engine is direct-connected to a generator, this procedure is not advisable, as the speed will be less uniform.

The best and most scientific method of eliminating unbalanced inertia effects is to attach a compensating device to the engine. This may consist of two masses, mounted eccentrically upon parallel shafts that rotated in opposite direction, produce a variable counter-inertia effect.

In some cases a simpler partial remedy is to alter the natural frequency of the houses by increasing the thickness of the walls. Or the engine speed may be changed sufficiently to eliminate resonance, but care must be taken that this does not produce resonance in other houses.

Fatigue Stresses Probably Caused Failure of the Greenwich Thermal Storer

Suppose that the fatigue limit of a piece of steel is 15 tons per square inch and that this piece is repeatedly stressed to 16 tons. We may expect it to stand 1,000 million repetitions of this stress before it fails. If the stress, however, to which it is subjected, is 17 tons, or two tons in excess of the fatigue limit, the life is reduced to one-sixteenth of the foregoing, and under a repeated stress of a little over 20 tons per square inch the number is reduced a thousand-fold or, in other words, to about one million. According to the law of fatigue, cracks and finally fractures occur in a material that is repeatedly stressed beyond its elastic or fatigue limit, the number of repetitions of stress until fracture occurs increasing as the fourth power of the excess stress.

In a discussion of dished and flat end plates for boilers, as covered in the memorandum by the chief engineer of the Manchester (England) Steam Users' Association for the Prevention of Steam Boiler Explosions, for the year 1922, the effects of fatigue are discussed. The Greenwich thermal storer contained water and was subjected to vibrating stresses caused by blowing steam into water. Failure occurred after six months' operation. It appeared that the material had been severely punished, and may have lowered the elastic limit by 50 per cent. A test pressure applied to steel end plates has never yet produced fractures at the roots of the flanges, even though these pressures were much in excess of those which cause explosions or failures after long application. These latter must be attributed to fatigue. When fatigue tests are used as a standard of comparison, the term "factor of safety" has no meaning.

The Development and Future of High Pressures and Temperatures*

By HENRY B. OATLEY

JACOB PERKINS, in 1822, was one of the first engineers to advocate and experiment with the higher steam pressures. He even attempted to approach the critical condition of 3,200 lb. and 706 deg. F. Evidently, he was far in advance of his time. It is stated that Ernst Albans, a German engineer working at about the same time, generated steam at 1,000 lb. pressure. In 1880 A. M. Perkins, of the Perkins Engine Co., Ltd., London, built and satisfactorily tested the steam yacht "Anthracite" at 350 lb. pressure. Pioneer work on high pressures was also carried on by a German engineer, Wilhelm Schmidt, prior to 1890.

Within the last year a great deal has been contributed on this question in the technical press and in papers presented before engineering societies. Attention has been given not only to the theoretical questions involved, but to the practical problems of design and operation.

Among the more recent developments in high-pressure steam generators mention can be made of two or three. The Atmos[1] boiler, designed by J. V. Blomquist, a Swedish engineer, has rotating tubes and is designed to carry a pressure as high as 1,500-lb. The Benson Engineering Co., Ltd., of London, is developing an experimental plant[2] to operate at the critical pressure of 3,200 lb. Hartman, a German engineer, in a paper presented in 1923 before the V. D. I. (Society of German engineers), outlined ten years

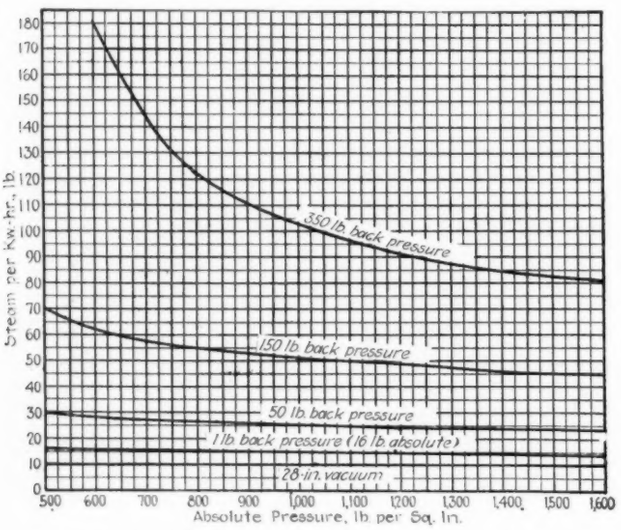

Steam per Kw.-hr., lb.
350 lb. back pressure
150 lb. back pressure
50 lb. back pressure
1 lb. back pressure (16 lb. absolute)
28-in. vacuum
Absolute Pressure, lb. per Sq. In.

FIG. 1—EFFECT OF BACK PRESSURE ON STEAM RATE

of successful experimenting with high pressures, in cooperation with Schmidt[3].

The curves of Fig. 1 show how the back pressure affects the relative steam rate obtainable with varying initial pressures. While it is obvious that a condition of high back pressure makes high initial pressure more advantageous, the curves help to show the importance of this relation. For example, with 150 lb. back pressure, such as might be used in connection with certain types of process work, the steam rate drops from 70 lb. per kw.-hr. at 500 lb. pressure to 45 lb. at 1,600 lb. pressure. Moreover, the fall in the steam rate does not tell the whole story. Looking at the 28-in. vacuum line to illustrate this point, it is seen that the steam rate remains practically constant at 10 lb. per kw.-hr. all the way from 500 lb. initial pressure up to 1,600 lb. This constant steam rate means a considerable increase in actual economy at the higher pressures, since the heat required to make a pound of steam steadily decreases beyond 500 lb. pressure.

Among the strictly American developments may be mentioned the 1,200-lb. installations at Weymouth and Calumet[4].

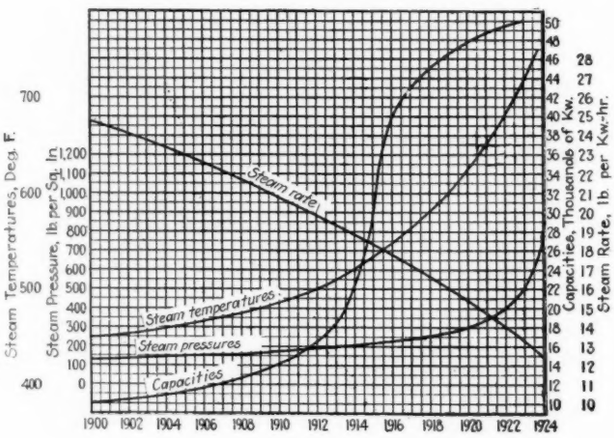

Steam Temperatures, Deg. F.
Steam Pressure, lb. per Sq. In.
Capacities, Thousands of Kw.
Steam Rate, lb. per Kw.-hr.
Steam rates
Steam temperatures
Steam pressures
Capacities
1900 1902 1904 1906 1908 1910 1912 1914 1916 1918 1920 1922 1924

FIG. 2—GENERAL TREND OF PRESSURES, TEMPERATURES, ETC.

In each of these installations the steam generated at 1,200 lb. pressure is utilized in a small turbine which exhausts at several hundred pounds into a reheater in the boiler setting from which it passes to the steam main, which supplies the "low-pressure" turbines.

Without making any pretence to accuracy, the curves of Fig. 2 show the general trend of temperatures, pressures, etc. Typical steam temperatures, starting at 450 in 1900, rose to 490 deg. in 1910, to 620 in 1920, and to 720 in 1923. The rise in steam pressures was at first more moderate, being only 125 lb. in 1900 to 175 in 1910. By 1920 300 lb. had been reached. In the three years since pressures have risen to 600 pounds.

Steam rates, as will be seen from the curve, decreased steadily throughout the entire period and are still falling. These steam rates are not to be understood as representing the actual and guaranteed rates of turbines under most favorable operating loads, but rather general water rates obtained in continued operations. The more rapid decrease in water rates during period 1910-20 shows the effect not only of increasing size of units, but of higher steam pressures and temperatures. The size of units increased rapidly from 1910 to about 1918. Since then there has been little increase in size. These curves, it should be understood, are of a general nature and merely show general trends.

At present there is a wide difference of opinion among engineers on this question of high pressures and high temperatures. Some look upon it as a natural development, and others as a passing fad. In this connection it must be remembered that if the total temperature is fixed, any increase in pressure means a decrease in superheat. For example, with 750 deg. maximum temperature there would be 360 deg. of superheat with 200 lb. pressure; 300 deg. with 400 lb.; 184 deg. with 1,200 lb.; and only 40 deg. at the critical pressure of 3,200 pounds.

At the present time the steam pressure in a great majority of commercial plants does not exceed 250 lb. A small

*Abstract of paper presented before Providence Engineering Society, Providence, Rhode Island, Nov. 6, 1923.

[1]Described in *Power*, Feb. 13, 1923.

[2]Described in *Power*, May 22 and 29, 1923.

[3]Much of this same material is covered in an article in *Power*, July 31, 1923.

[4]The Weymouth installation was described in *Power*, July 10, 1923, and the Calumet installation in the May 29, 1923 issue.

number of plants are operating in the range from 250 lb. to 600, and perhaps a half dozen others are under construction at the present time. So far as can be determined, no American boiler has been in operation for long at pressures above 600 pounds.

In connection with high pressures we must consider not only the present method of passing steam to the prime mover and then to the condenser, but also the newer method wherein the high-pressure steam goes first to a small turbine and is then reheated before passing to the larger turbines.

The use of higher pressures will undoubtedly lead to changes in boiler design. The horizontal return-tubular boiler, which stood the test of time in a satisfactory way for pressures up to 180 lb., could not be used for 250 lb. In the same way it is to be expected that boilers that are entirely satisfactory at 200 or 300 lb. may require important modifications to carry 1,000 to 1,200 lb.

Factors That Must Be Considered

In boiler design as well as in the construction of superheaters, the following factors must be given most careful study: Safety, minimum number of joints, adequate steam space and steam disengaging surface, rapid water circulation through tubes, suitable location and design of superheater, economizer and air preheater, suitable design of water-level indicator, piping connections for both water and steam, attachment of tubes and pipes.

Safety is affected by both temperature and pressure. The metal temperature in boilers necessarily increases with the pressure. In superheaters metal temperatures now used will be increased but little, if at all, because the commonly used steam temperatures are in excess of the temperature of saturated steam even up to the critical pressure at which 706 deg. represents saturated steam. The increase in pressure, however, requires additional thickness in walls, unless sizes are reduced. Prudence would therefore dictate that diameters of tubes and drums be kept as small as possible, in order that weight and costs be conserved. Tubes and drums should unquestionably be seamless and riveted joints eliminated so far as possible.

The minimum number of joints for all boiler and superheater connections should be aimed at. Manholes, where necessary, must be specially designed and made as small as possible.

Steam space and disengaging area in boilers are always important, and adequacy in design becomes more necesssary as pressures increase. The amount of moisture carried with the steam into the superheater and piping often causes trouble by decreasing the degree of superheat with resulting loss in economy. Rapidity of circulation is a factor of safety whose importance increases with the metal temperature.

Water-Level Indicators and Pipe Connections

Suitable design of water-level indicators seems likely to be solved by apparatus different from the commonly used gage glasses, which thus far have not been suitable for very high pressures.

Piping connections for steam and water may require modification. Experience thus far with pressures above 800 lb. indicates that tubes rolled into sheets or headers in the normal way will not have sufficient durability. Undoubtedly, a solution of this problem will be found. Superheaters, even more than boilers, require careful study, and while the general features may not change from present practice, it is probable that proportions will require considerable modification.

Manufacturers of steam gages and safety valves may be trusted to provide safe and accurate instruments, but possibly will change materials used and methods of fabrication of the parts. Steam piping will, of course, be smaller and the reduction in size will offset to a considerable extent the natural increase in cost of piping for these high-pressure lines. Boiler and stop valves will undoubtedly increase in cost in spite of the reduction in size.

In the discussion of Mr. Moulthrop's paper on the Weymouth Station at the Swampscott Meeting of A.I.E.E. this year, many conflicting views were found regarding air heaters, economizers, sizes of boiler tubes and other details. Such diversity of views was to be expected in the pioneering of any development. Many of these moot questions will be easily settled in the near future, while others will remain for discussion indefinitely.

The query has presumably been in your minds, as it is in the minds of many, "What is the most advantageous steam pressure and steam temperature to adopt?" Answers to this query will cover a wide range and reflect the attitude of many who have approached the question from different premises.

George Orrok, in his paper presented at the 1922 Annual Meeting of the American Society of Mechanical Engineers, balanced the increased efficiency due to higher pressures (using the Rankine cycle as the yardstick) against the increased fixed charges due to the higher equipment costs. His conclusion is that pressures above those commonly used at the present time are not justified with temperatures below 750 deg. F. With the regenerative cycle as a yardstick the increase in efficiency at the higher pressures being greater, there would be justification for raising the pressure limit. While the regenerative cycle is, strictly speaking, only a theoretical consideration and cannot be fully realized in practice, a satisfactory approach to the ideal is found in multi-stage bleeder heating and, with this included, higher pressures become more attractive.

It is quite evident that economies obtained through superpressure with multi-stage reheating are appreciated by many, and the plants under consideration in this country as well as Belgium and Germany point the way for development.

The fact should be kept in mind that for the moment we are confronted in this problem, as in all new developments, with relatively high costs for engineering, designing and fabrication of suitable boilers, turbines, valves, etc. Fortunately we have progressive executives who realize that there are further gains to be had and that someone has to make a start. They have evidenced courage in their convictions by authorizing the purchase of such equipment in spite of the high pioneering cost. After a few plants have been in operation, the extra costs just mentioned will be reduced. More will then be known of the *actual* results from the use of superpressures, and it is altogether probable that steam pressures of 800 lb. per sq.in. and upward will, when combined with reheating and the proper use of back pressures, be found advantageous from a broad economic standpoint.

The speaker believes that Mr. Moulthrop and the other executives who have decided upon these initial superpressure installations, are to be congratulated and that the engineering profession is also to be congratulated on the possession of such as members.

In conclusion, the speaker feels that this paper will have served a purpose, although it contains very little that is new, if it has placed the general question before his audience and aroused interest in the advantages, or disadvantages, of increasing steam pressures and steam temperatures.

There is no need for laboratory precision in the apparatus measuring the coal and water. If a commercial accuracy of 2 per cent is obtained, it is all that is necessary, for it is doubtful whether the integrating wattmeters which measure the electrical output of the station can be relied on within this limit of accuracy. It is the continuous registration of performance, shift by shift, so that comparisons can be made, which is the essential matter, and not the perfect accuracy of individual observations. Elaborate boiler tests, conducted at intervals, are of little more than academic interest. They demoralize the station while they are being prepared for and carried out, and do much less to promote efficiency of operation than simple continuous records. Even if they indicated what a boiler could do under working conditions, they certainly do not show what it does do, for within half an hour after an efficiency of, say, 80 per cent has been shown on test, the boiler may be operating at an efficiency of 60 per cent or even less without anything being very obviously wrong.—*Engineering.*

News in the Field of Power

Cross-Compound Reaction Turbine for Hell Gate

A new unit of 50,000-kw. capacity, to be known as Number Six, is to be built for Hell Gate Station of the United Electric Light and Power Co. by the Westinghouse Electric & Manufacturing Co.

The turbine is a cross-compound unit with a maximum capacity of 56,250-kw. The two generators will total 62,500 kva., delivering three phase-current at 13,200 volts 60 cycles. The high-pressure turbine contains an impulse wheel, and Parsons reaction blading with conical boring. The low-pressure turbine is straight double-flow, with Parsons reaction blading, conical boring, the last rows of blading being of the Bauman type with stream-line exhaust. Strictly speaking, the unit will have no bedplate, being mounted on special leveling chucks fitted directly to the steel work of the foundation.

This will be operated as a single unit, the terminals of both generators being always tied together. In starting both elements will come up to speed together, necessitating only one synchronizing operation. There will be no governor on the low-pressure turbine with the exception of an overspeed device, the governing being done at the high-pressure turbine. The high pressure turbine will also be fitted with an overspeed governor, which, by means of oil pressure, can be tested at or below normal speed.

Steam from the high-pressure turbine is led to the low-pressure turbine by means of an overhead pipe. The unit will have a self-contained oiling system, but each turbine will be equipped with an individual oil pump.

A 2,500-kva. house generator will be installed as an extension of, and driven by the high-pressure element. The exciter for this generator will be mounted on the same shaft. The exciter for both main units will be mounted on the shaft of the low-pressure element.

Steam is supplied at 265 lb. 200 deg. superheat, exhausting into a 29 in. vacuum with four bleeder openings.

The over-all length of the high-pressure element is 62½ ft., low-pressure, 55 ft. 2 in. and overall width, both units, 35 ft. 6 in. Height above floor to top of interconnecting pipe is 22 ft. 10 in.

The high-pressure element consists of a 25,000-kw. turbine driving a 31,250 kva. 80 per cent P.F. 3-phase 60-cycle 13,200-volt generator, and a 2,500-kva. 80 per cent P.F. 3-phase 60-cycle 2,400-volt generator, as well as a 45-kw. 250-volt exciter; speed, 1,800 r.p.m.

The low-pressure element is a 25,000-kw. turbine driving a 31,250-kva. 80 per cent P.F. 3-phase 60-cycle, 13,200-volt generator and a 240-kw. 250-volt exciter, at 1,800 r.p.m.

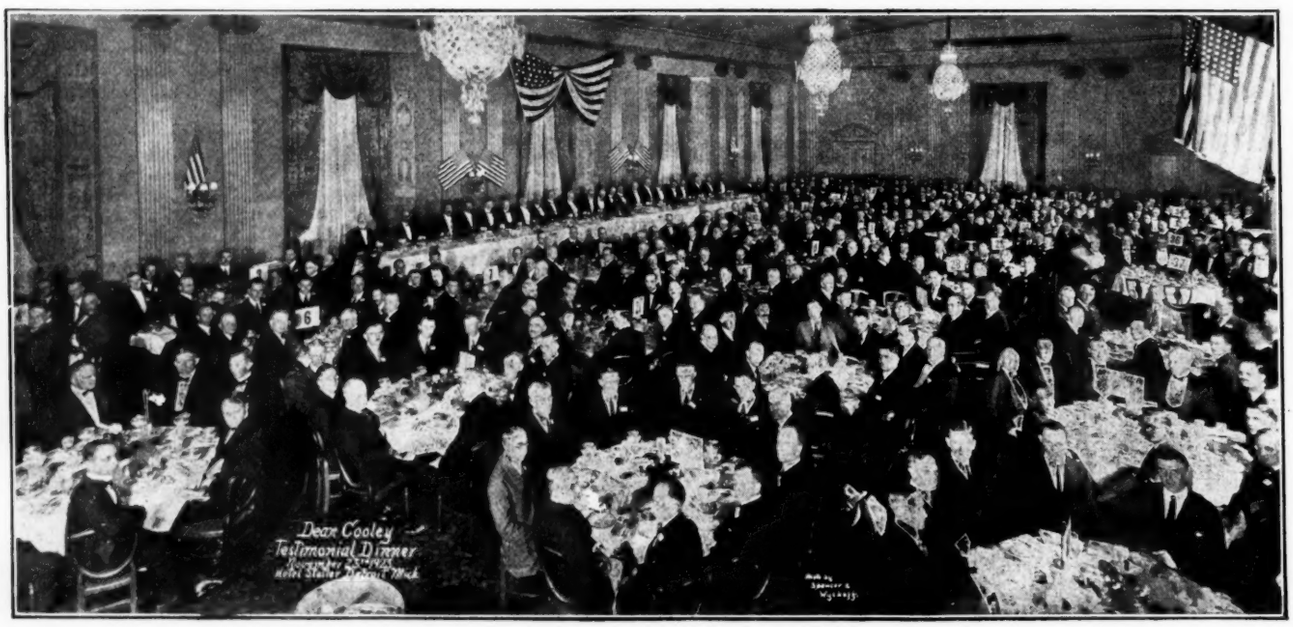
The turbine room at Hell Gate contains two 40,000 kw. Westinghouse, two 35,000 kw. General Electric and two 2,000 kw. Westinghouse units.

Cincinnati To Have Big Power Plant

The Union Gas & Electric Co., Cincinnati, will erect a $15,000,000 electrical generating plant at the confluence of the Big Miami and Ohio Rivers, below Cincinnati. Building operations on this gigantic project will begin next April. The plant will comprise a number of buildings, including an administration building and a building for the storage of 500,000 tons of coal. The plant will also be equipped with the modern facilities for handling coal.

Discuss Electrical Accident Insurance

At the recent meeting of the Connecticut Section, A.I.E.E., at Hartford, Conn., Nov. 22, W. R. C. Corson, vice-president, Hartford Steam Boiler Inspection and Insurance Co., outlined the recent development of electrical accident insurance in this country and emphasized the need of further experience in order to determine satisfactory rates for power-plant and electrical installations. In a general discussion that followed the author's historical survey it was brought out that about sixteen companies are now writing engineering insurance in America, about half of these also writing electrical insurance. It is roughly estimated that the total volume of electrical insurance in the United States is about eight million dollars. The past year's



TESTIMONIAL DINNER GIVEN TO DEAN COOLEY, AT DETROIT, MICH., NOV. 23

experience shows that premiums will have to be increased unless losses can be reduced by inspection and by the co-operation of plant owners and operators.

The importance of more closely defining "fire" in the insurance of electrical machinery against loss was featured in the discussion. There have been disagreements between casualty and fire insurance companies as to mutual liability for damages in turbo-generator burnouts for example. In one case it cost $8,000 to rewind a 30,000-kw. generating unit, the winding of which had been damaged by internal overheating resulting in insulation destruction. This was accompanied by smoke, but the fire insurance interests contended against sharing in the damages on the ground that the accident was not a fire in the accepted sense. The courts held otherwise, and all the insurance interests shared the loss.

A. D. Colvin, general manager, Hartford Electric Light Co., pointed out the opportunities for standardizing inspections covering the same plant. In a typical case two inspectors went over the same plant and the reports and recommendations differed radically. Each list of points presented had merit, but there was not the concurrence of view one would have expected. Much depends, the speaker said, upon the use made of insured machinery, some equipment held chiefly for reserve service deserving a different rating from the more modern apparatus, in regard to premiums. H. W. Derry, power engineer, Hartford Electric Light Co., pointed out that the attention of all purchasers of motors is drawn to the value of breakdown insurance, and as a result the insurance taken out in many cases has helped materially in weeding out operating troubles.

Water Power Project Would Increase Height of Cherokee Bluffs Dam

The Alabama Power Co. has applied for a license covering the remainder of its project on the Tallapoosa River. A year ago the company secured a preliminary permit for a series of developments that would make possible the complete utilization of all the power that can be secured from the river. In June a license was issued covering the company's Cherokee Bluffs' unit, which develops 100,000 horsepower.

The company has completed its survey of the entire stream, and it discloses that it will not be possible to secure the storage capacity estimated. For that reason it is proposed to increase the height of the Cherokee Bluffs' dam from 105-ft. to 150 ft. This change, however, will entail very heavy expense. Five additional dams are to be constructed above the Cherokee Bluffs dam, which will have a combined head of 306 ft. The fifth dam will be 140 ft. high. The combined installed power at these additional dams will be 114,000 horsepower.

Muscle Shoals Occupies Center of Stage at Washington

The new Congress had not perfected its organization when bills for the disposal of the Government's properties at Muscle Shoals were tossed into the hopper of the House. All of the several early measures provided for lease of the projects to Henry Ford.

Representative J. C. McKenzie, of Illinois, reintroduced without change the bill agreed upon in the last Congress by a majority of the members of the House Military Affairs Committee. This provides for acceptance of the Ford offer for the hydro-electric development, the nitrate plants, quarry, railroad and other properties on the terms of the Ford bid, but excludes the Gorgas steam plant. It was exclusion of this auxiliary plant which caused several minority bills to come from the committee in the last Congress. In the meanwhile the War Department has sold the Gorgas plant to the Alabama Power Company.

Representatives Vinson, of Georgia, and Almon, of Alabama, introduced bills accepting the Ford offer without change. These bills evidently would make it incumbent upon the government to build a new steam plant on the Warrior River with a transmission line to Muscle Shoals.

Henry Ford's conference with the President and the Secretary of War has also been made the occasion for much speculation.

Proportioning Costs in Hydro-Electric Developments

Discussing the items entering into the cost of water-power development in the second Aldred lecture before the faculty, graduate and senior students of the Massachusetts Institute of Technology, Nov. 23, Julian C. Smith, vice-president and general manager, Shawinigan Water & Power Co., Montreal, presented the following tabulation of the proportional investment in a typical case:

TYPICAL PERCENTAGES OF INVESTMENT COST IN WATER-POWER DEVELOPMENT

	Per cent
Preliminary work including expenses of engineering, reports, legal advice, etc.	2
Lands, etc.	7
Discount on bonds	9
Interest during construction	9
Legal	1
Engineering and superintendence	5
Head office expenses	2
Insurance	1
Construction of buildings and camps	2
Construction plant	9
Cofferdams and tracks	7
Dams	13
Power house	13
Machinery	18
Operators' houses, roads, etc., misc.	2
Total	100

Commenting upon this tabulation, Mr. Smith said that about 35 per cent is made up of items not connected with direct expenditures in the field; about 20 per cent is for temporary equipment like cofferdams, tracks, etc., which might be called preliminary work; and only about 47 per cent represents money going into permanent work.

Touching upon probable future developments in water-power engineering in its broadest sense, the speaker pointed out that modern waterwheels operating under good conditions develop over 90 per cent theoretical power. The possible gain here is not over 4 or 5 per cent at best. The generators have efficiencies ranging from 95 to 97 per cent, and it is more a question of the amount of money one wishes to spend in the design and construction of a generator, than any other factor, that determines the maximum efficiency. The speaker believes that generators of 98 per cent efficiency can be built if the purchaser is prepared to pay the price. The general arrangement of waterwheels and generators and the design of power-plant structures has in the last few years become more or less standardized.

If the speed of the generating units can be increased for a given head or if the speed of the water through the passages can be increased so that the passages can be made smaller, the overall cost of the power plant and machinery will be reduced. Recent designs in some cases involve about double the speeds of Francis turbines under the same head for the same power. It is a fair assumption that by doubling the speed, the cost of the electrical machinery can be reduced by 25 per cent, which means a reduction of 2 or 3 per cent in the total cost of development—a substantial and worthwhile saving.

New Publications

The Welding Encyclopedia. Third edition, compiled and edited by L. B. MacKenzie and H. S. Card, of the editorial staff of *The Welding Engineer*. Published by The Welding Engineer Publishing Co., 608 South Dearborn St., Chicago, Ill. Flexible leather; 6x9 in.; 437 pages; 600 illustrations. Price, $5.

First published in 1921, the second edition of the Welding Encyclopedia appeared in 1922, and a third edition now appears. This rapid succession of revisions shows that the editors are fully alive to the importance of keeping the work up to date in a rapidly developing field. This is a reference and instruction book on the theory and practice of all welding processes, the material being arranged in alphabetical form, so that any subject or detail may be looked up without delay. In addition to the regular encyclopedia section, consisting mainly of definitions and short discussions, there are special chapters devoted to oxyacetylene welding, electric arc welding, thermit welding and resistance welding. Additional chapters treat separately of boiler welding, pipe welding, tank welding, etc., by either the gas or electric processes. A special section deals with the rules and regulations for the installation and care of welding apparatus. An entirely new feature of this edition is the chapter on training operators.

This is followed by exercises and examinations. The book appears to be thoroughly practical and should be of great value to all those who have anything to do with welding.

English for Engineers. By S. A. Harbarger. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Cloth; 266 pages; 5x7½ in. Price, $2.

In the preface of this textbook the author says that the object of it is to "make the study of English definite for the engineering student and to stimulate his interest in a brief but comprehensive survey of the immediate uses to which English may be put by the engineer." Several chapters deal with the writing of letters, especially sales letters, others are devoted to the preparation of abstracts, summaries, book reviews, technical articles and reports. Although containing 266 pages, the value of the book would have been enhanced by the inclusion of concrete help in the use of English. The technical student is trained along lines of definite and concrete statement, and generalizations, along any line, usually fail to register with sufficient emphasis upon his brain to be of value to him. Examples of ordinary mistakes in English such as come to the desk of an editor might have been included and would have been of real assistance to the student.

Design of Diagrams for Engineering Formulas. By Laurence I. Hewes, Deputy Chief Engineer, United States Bureau of Public Roads, and Herbert L. Seward, Associate Professor of Mechanical Engineering, Sheffield Scientific School, Yale University. Published by the McGraw-Hill Book Company, Inc., 370 Seventh Ave., New York City. Cloth; 9x12 in.; 111 pages; 82 illustrations. Price, $5.

The publication of a treatise on "nomographie" by the French professor, d'Ocagne, many years ago awakened general interest in the solution of formulas by diagrams. The authors of the present volume have had much to do with the fostering of this interest in the United States. The book is largely an outgrowth of a course given in the Sheffield Scientific School for the last nineteen years. It is designed for those who wish to acquire a thorough knowledge of the fundamental mathematical principles that underlie all the common types of computing diagrams. A reasonable acquaintance with mathematics, including a knowledge of determinants, is necessary for its understanding. Determinants, however, are covered in the appendix. The book starts with a discussion of "function scales," showing what they are, how one may be derived from another and how suitable scale factors may be selected. It then goes on to discuss the making of diagrams consisting of families of curves for solving equations of three variables. In this connection the methods shown for straightening out curves by the use of special non-uniform scales are of particular interest. The following chapter deals with alignment diagrams, the treatment being based entirely upon determinants. The types of diagrams shown include those with three parallel scales, those with two parallel scales crossed at an angle by a third, and those with a combination of straight and curved scales. Finally comes the treatment of more complicated alignment diagrams, such as those with more than three variables, those with two or more indices and those using several networks of curves. In addition to the small sketches illustrating the theory, there are many large-scale diagrams for well-known engineering formulas. The problems at the end of each chapter add to the value of the book as a text for senior or graduate students in technical schools.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonion Institution Bldg., Washington, D. C. Seventy-fifth anniversary meeting at University of Cincinnati, Cincinnati, Ohio, Dec. 27-Jan. 2.

American Engineering Council of the F.A.E.S. L. W. Wallace, 24 Jackson Place, Washington, D. C. Meeting at Washington, D. C., Jan. 10-11.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at Philadelphia, Feb. 4-8.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 18-21.

American Petroleum Institute. R. L. Walsh, 15 West 44th St., New York City. Fourth annual meeting at Statler Hotel, St. Louis, Mo., Dec. 11-13.

American Society of Heating & Ventilating Engineers. C. W. Obert, 25 West 39th St., New York City. Annual meeting at New York City, Jan. 22-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring meeting, at Cleveland, Ohio, May 19-22.

American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Canada. Annual General Meeting at Montreal, Quebec, Jan. 22—Ottawa, Ontario, Jan. 23-24.

Iowa Engineering Society. Blanche Veig, Acting Secretary, 406 Flynn Bldg., Des Moines, Iowa. Annual meeting at Cedar Rapids, Jan. 29-Feb. 1, 1924.

Kansas Engineering Society. C. V. Waddington, Kansas Gas & Electric Co., Wichita, Kans. Convention at Wichita, Kans., Dec. 11-13.

Master Boiler Makers Association. H. D. Vought, 26 Courtland St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Practical Refrigerating Engineers; Ed. H. Fox, 5707 W. Lake St., Chicago. Fourteenth Annual Convention at Memphis, Dec. 12-16.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 11-13, 1924.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

The National Industrial Conference Board has, in Research Report No. 64, issued a comprehensive study of tax burdens and exemption. Some of the facts brought out that are startling are: Total taxes paid in the United States in 1922 aggregated $7,061,000,000. This amounted to 12.1 per cent, or nearly one-eighth, of the national income. It meant a cost of $64.63 to every man, woman and child. Each person had to contribute the income of 6¼ weeks to support the government in 1922 as compared with 3¾ weeks before the war. State and local taxes formed more than half (58 per cent) of the total taxes. The public payroll included nearly 3,400,000 persons. Every eleven workers 16 years of age and over, supported one public employee. The cost of salaries of public employees aggregated $3,800,000,000, or $91 for every person ten years of age and over gainfully employed, or $35 for every man, woman and child. Copies of this report can be obtained from the National Industrial Conference Board, 10 East 39th St., New York City, for $2 in paper and $2.50 in cloth binding.

Society Affairs

The New York Section of the A.I.E.E. will hear Professor Giddings speak on "Human Engineering" at its Dec. 19 meeting.

The Cincinnati-Liberty Section No. 15, N.A.S.E., Cincinnati, Ohio, will have as the subject of its Dec. 22 meeting "Metallic Packing."

The Schenectady Section of the A.S.M.E. will hear F. L. Morse, of the Morse Chain Co., give a "History of Power Transmission" at its Dec. 14 meeting.

The Metropolitan Section of the A.S.M.E. will have as the topic for its Dec. 18 meeting, "Low Temperature Distillation of Coal." William H. Velt is to be the speaker.

The American Marine Engineer, official organ of the National Marine Engineer's Association has changed its offices from 240 Broadway to Temple Court, 5 Beekman St., New York City.

The Providence Engineering Society will hold a joint meeting with the Providence Section of the A.I.E.E. on Jan. 4, at which Linn Helander, Westinghouse Electric & Manufacturing Co., will speak on "Some Features of Modern Large Turbine Installations."

Personal Mention

L. A. Osbourne, President of the Westinghouse International Co., has recently been decorated by the Japanese Emperor with the third order of the Rising Sun.

Robert L. Sheraton, formerly assistant to the president of the Edward Valve & Manufacturing Co., has been elected a vice-president of the Continental Valve Equipment Co. Mr. Sheraton will make his headquarters at the factory in Framingham, Mass.

Business Notes

The Bridgeport Brass Co., Bridgeport, Conn., announces the appointment of E. E. Helm as district manager at Detroit, Mich.

Dwight P. Robinson & Co., Inc., of New York City have opened an office in the Healey Bldg., Atlanta, Ga. W. Rawson Collier, formerly with the Poughkeepsie Gas & Electric Co., will be in charge.

Stagg & Hungerford is the name of a new firm which has been formed for the wholesale distribution of anthracite and bituminous coal. Its office is in the Whitehall Bldg., New York City.

The E. Keeler Co., Williamsport, Pa., manufacturer of boilers, etc., announces the appointment of C. C. Loder as sales manager, Pittsburgh territory, with headquarters at 609 Chamber of Commerce Bldg., Pittsburgh, Pa.

Tate-Jones & Co., Inc., Furnace Engineers, Pittsburgh, Pa., announce the appointment of G. Bluemel as district sales manager for territory covering New York, New England and New Jersey, with headquarters at 50 Church St., New York City.

The McClave-Brooks Co., Scranton, Pa., announces the appointment of Byron Ashdown as sales representative at St. Louis, with offices in the Syndicate Trust Bldg.

Trade Catalogs

Turbines—B. F. Sturtevant Co., Boston, Mass. Catalog No. 311 describes with suitable illustrations the construction, general principles, care and operation of type No. 12 turbine.

Pumps — D'Olier Centrifugal Pump and Machine Co., 165 Broadway, New York City. Bulletin No. 126-3 describes and illustrates some of the largest pumps built by this company.

Switches, Service—The Johns-Pratt Co., Hartford, Conn. Catalog entitled "Noark Universal Service Switches," describes standardized switches for single-phase and direct-current service.

Hoists — The Brown Hoisting Machinery Co., Cleveland, Ohio. Booklet No. 10, "Man-Power Multiplied," describes with many illustrations the uses and the construction, of these hoists. Tables of capacities and dimensions are given.

Turboblower—B. F. Sturtevant Co., Hyde Park, Boston, Mass. Catalog No. 312 shows the construction and general principles, gives instructions on the care and operations of, and includes photographs and line drawings of the individual parts of design No. 1 turboblower.

Welding, Cast Iron—Linde Air Products Co. "Cast Iron Welding by the Oxyacetylene Process," compiled by T. C. Fetherston, is somewhat in the nature of a textbook, as every phase of this subject is handled with authority. It contains numerous illustrations which serve to clarify the explanations.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Nov. 26, 1923	Dec. 3 1923
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.50	2.25
Somerset	Boston	2.75	2.50
Kanawha	Columbus	2.00	2.00
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	2.00	1.95
Franklin, Ill	Chicago	2.50	2.50
Central, Ill	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.75	2.75
West Ky	Louisville	2.00	1.90
S. E. Ky	Louisville	2.25	2.00
Big Seam	Birmingham	2.15	2.15

New York—Dec. 6, light oil, tank car lots, 28@34 deg. Baumé, 3¾c. per gal., 36@40 deg. 4c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Nov. 27, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.50 per bbl.; 26@28 deg., $1.55; 28@30 deg., $1.60; 32@36 deg., gas oil, $1.80 per bbl.; 36@40 deg., distillate, 5½c. per gal.

Pittsburgh—Nov. 30 f.o.b. local refinery, 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5¾c.; 34 deg., neutral 8c. per gal.

Dallas—Nov. 30, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Cincinnati—Dec. 4, tank-car lots, f.o.b. local refinery, 26@30 deg. Baumé, 5c. per gal.; 30@32 deg., 5¼c.; 38@42 deg., distillate, 6¼c. per gal.

Philadelphia—Nov. 30, 28@30 deg., $1.57½@1.62 7/10 per bbl.; 18@22 deg., $1.47@1.51 7/10; 13@16 deg., $1.36½@1.40 7/10 per bbl.

Chicago—Nov. 30, 24@26 deg., $1.62 per bbl.; gas oil, 32@36 deg., $1.97 per bbl.

Boston—Dec. 4, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 6¼c. per gal.

New Plant Construction

PROPOSED WORK

Calif., Crows Landing—The Stanislaus Irrigation Dist. will be reorganized to include about 36,000 acres. It is planned to divert waters from San Joaquin River for irrigation purposes by the installation of centrifugal pumps from 20 to 36 in., operated by electric motors. E. N. Bryan, Forum Bldg., Sacramento, Consult. Engr. Noted Oct. 24, 1922.

Calif., Fresno — The Service Rock Co., Valley Bank Bldg., H. W. Jones, Mgr., is in the market for equipment for sand and gravel plant, including electric motors, etc.

Calif., Los Angeles — The Los Angeles Lodge B. P. O. E., 300 South Olive St., is having preliminary plans prepared for the construction of a 12 story club building on Parkview and 6th St. Estimated cost $1,250,000. Curlett & Beelman, Union Bank Bldg., Los Angeles, Archts.

Calif., Marysville — The Yuba Development Co., Hobart Bldg., San Francisco, is having plans prepared for the construction of a storage dam about 150 ft. high above stream bed, 65 ft. below bed, 825 ft. long on crest, 200 ft. long on bottom, involving 97,000 cu.yd. concrete; concrete lined pressure tunnel, 1,700 ft. long, 15 in. diameter; 300 ft. steel penstock; power plant to develop 17,000 hp. on the Yuba River, here. Constant Angle Arch Dam Co., Hobart Bldg., San Francisco, Engrs.

Calif., Pescadero—D. H. Atkins, 260 California St., San Francisco, representing owners, is having plans prepared for the construction of an irrigation system, including three dams, pumping plants, centrifugal pumps, motors, canals and pipe lines, here. C. E. Grunsky, Jr., Mechanics Institute Bldg., San Francisco, Engr.

Calif., San Francisco—The Pacific Gas & Electric Co., 445 Sutter St., is having plans prepared for the construction of a 2 story substation on Commercial and Montgomery Sts. Estimated cost $500,000, including equipment. Private plans.

Calif., San Francisco—The Pacific Telephone & Telegraph Co., 333 Grant Ave., is having plans prepared for the construction of a 26 story office building on New Montgomery St. Estimated cost $2,500,000. T. Ronneberg, Crocker Bldg., Engr. Miller & Pflueger, Lick Bldg., associated with A. A. Cantin, 68 Post St., Archts. Equipment detail not reported. Noted July 10.

Calif., San Jacinto—Soboda Hot Springs, c/o J. J. Frauenfelder, Archt., Story Bldg., Los Angeles, is having preliminary plans prepared for the construction of resort buildings, including hotel, laundry, power house, etc., here.

D. C., Wash.—The Office of the United States Engineer, Old Land Office Bldg., 8th and F Sts., N. W., N. C. Tyler, Officer in Charge, is having plans prepared for the construction of a hydro-electric plant, filtration plant, reservoirs and completion of conduits, Conduit Rd., Md. and D. C. Noted Aug. 28.

Fla., Tampa—The Swann Terminal Co., 314 Madison St., had plans prepared for the construction of a 140 x 600 ft. warehouse, 5 story, 140 x 600 ft. millwork building, including cold storage plant, offices, etc. Estimated cost $750,000. Lockwood, Green & Co., Healey Bldg., Atlanta, Ga., Archts.

Ill., Chicago—A. N. Ruttenberg, Archt., 54 West Randolph St., is receiving bids for the construction of a 1 story, 138 x 163 ft. ice factory at 5929 East Ravenswood Ave. for the Egan Ice Co., 5931 Ravenswood Ave. Estimated cost $30,000. The owner is in the market for ice manufacturing machinery.

Ill., Olney—The city is having preliminary plans prepared for the installation of electrical equipment for waterworks pumping plant, improvements to distribution system, etc. Estimated cost $75,000. A. J. Wharf, City Hall, Engr.

Ill., Pinckneyville—The Burke Coal Co., 1626 Chemical Bldg., St. Louis, J. T. Burke,

Purch. Agt., is in the market for an electrically driven coal conveyor, tipple machinery, pumps, motors, etc., for mine, 500 ton daily capacity, near here. Correction of Nov. 27 item.

Ia., Shenandoah—The city, F. Sanman, Clk., defeated $175,000 bonds for the construction of an electric light and power plant. Noted July 3.

Kan., Topeka — The Kaw Packing Co. plans to build a power plant and to purchase two steam boilers, engines, etc.

Ky., Louisville — The City & County Tuberculosis Hospital, 215 East Walnut St., is having plans prepared for the construction of a hospital on 18th St. Estimated cost $1,000,000. A. Loomis, Todd Bldg., Louisville, Archt. Equipment detail not reported.

La., Melville—The town voted for an increase from $45,000 to $60,000 for the construction of a waterworks and electric light system. Bids will be received about Feb., 1924. Swanson-McGraw, Inc., United Fruit Bldg., New Orleans, Engrs.

Md., Baltimore—The Standard Sanitary Mfg. Co., Bessemer Bldg., Pittsburgh, Pa., is having plans prepared for the construction of a 2 story, 171 x 350 ft. warehouse, 154 x 345 ft. enamel shop, 102 x 197 ft. cleaning house, 97 x 589 ft. foundry, 100 x 250 ft. machine shop, 107 x 132 ft. power house and 100 x 120 ft. enamel power mill on 5th Ave. from 7th St. to Camp Holabird, here. Estimated cost $2,000,000. S. Deischer & Sons, Farmers Bank Bldg., Pittsburgh, Archts. Noted May 29.

Mass., Worcester—The Boston & Maine R.R., North Sta., Boston, plans to build a power house at its yards, here. Estimated cost $75,000. A. B. Corthell, Ch. Engr. Equipment will be purchased. A. W. Munster, Purch. Agt.

Mich., Detroit — The Dept. Public Wks. will receive bids until Dec. 14 for furnishing and installing two 24 in. vertical centrifugal motor driven pumps, two 15 in. pumps, one 2½ in. centrifugal sump pump, motors, one 3½ x 4 in. electrically operated air compressor, also suction and discharge piping and shaft bracing for shafts of pumps. G. Jerome, City Hall, Engr.

Miss., Canton — W. M. Reid, Supt. of Water & Light Plant, is receiving bids for a smokestack for power plant, complete pumping outfit and the construction of a shallow well, 10 to 12 in., 390 to 400 ft. deep.

Mo., Flat River—The St. Joseph Lead Co. is having preliminary plans prepared for a complete waterworks and distribution system, including pumping plant, filtration plant and distribution mains. Estimated cost $35,000. Private plans.

Mo., Greenfield—The city is having plans prepared for the construction of 6½ mi. of sewers, two sewage disposal plants, 75,000 gal. concrete reservoir, one deep well and three pumping units. W. B. Rollins & Co., 521 Ry. Exch. Bldg., Kansas City, Engrs. Noted Oct. 2.

Mo., Poplar Bluff—I. W. Rodgers and H. E. Springer are having preliminary plans prepared for the construction of power plant, concentrate mill and washer, etc., with conveyor system near the Taskee Iron Mine. Estimated cost $200,000. Private plans.

Mo., St. Louis—The city, Bd. of Public Service, will receive bids Jan. 2 for complete refrigeration plant, including one 8 and one 15 ton compressor; 6 x 11 x 21 ft. freezing tank; 5 x 7 x 13 ft. brine tank; high and low pressure ammonia line, etc., for the Training School for Feeble Minded. Estimated cost $25,000.

Mo., St. Louis — R. C. Stanhope, 4512 McPherson St., is in the market for a 25 hp. oil engine, also a 50 hp. oil engine generator set, a.c., 2,300 r.p.m.

Mo., St. Louis—The Teuscher Pulley Belting Co., 801 North 2nd St., is in the market for a 150 hp. water heater for exhaust steam.

N. Y., Valatie—The Centennial Paper Mills, Inc., P. Houston, Secy., is in the market for one steam turbine direct connected with a 200 kw. generator complete with switchboard, etc., 175 lb. pressure at intake, 35 lb. back pressure at exhaust.

N. C., Murphy — The Southern Appalachian Power Co. plans to build a power house, dam 170 ft. high, etc., on the Hiawassee River in Cherokee and Clay Counties, to develop 50,000 hp. This will be the first unit of extensive development plans.

Ohio, Cincinnati—The Clerk of the Bd. Educ., 511 West Court St., will receive bids until Dec. 24 for heating and ventilating system for the 25th Dist. School on Tremont St. Cost will exceed $25,000. W. E. Bodenstein, 405 2nd Natl. Bank Bldg., Cincinnati, Engr.

Ohio, Cincinnati—The Union Gas & Electric Co., 4th and Plum Sts., is having plans prepared for the construction of an electrical generating plant, including administration building, coal storage building, etc. Four to eight steam turbines, 60,000 hp., also coal handling equipment will be installed. Estimated cost $15,000,000. Sargent & Lundy, 72 West Adams St., Chicago, Engrs. Noted Nov. 27.

Okla., Hooker—The city voted $16,000 bonds for electric light extensions and new pumping equipment. F. E. Devlin, Wichita, Kan., Engr.

Okla., Okemah—The city will hold an election Dec. 18 to vote $65,000 bonds for a new filter unit, pipe line, marine engine driven pumping unit, clear well and reservoir. Holway Eng. Co., Wright Bldg., Tulsa, Engrs. Noted Oct. 23.

Ore., Portland—The Portland Pulp & Paper Co., 815 Broadway Bldg., R. H. Mills, Pres., plans to build a 1 and 2 story paper plant. Estimated cost $1,250,000. The owner is in the market for machinery.

Tenn., Gallatin—The city, W. H. Brown, Mayor, is having plans prepared and will soon receive bids for waterworks improvements, including concrete well, filtration unit and a 1 story pump house. Estimated cost $40,000. B. H. Klyce, 4th and 1st Natl. Bank Bldg., Nashville, Engr.

Tenn., Memphis — W. Ahlschlager, Inc., Archt., 65 East Huron St., Chicago, will receive bids until Dec. 17 for the construction of a 12 story hotel to contain 600 rooms on Union Ave., South 2nd and 3rd Sts., for the Hotel Peabody representing the Southern Hotel Co., Inc., here. Estimated cost $3,000,000. Equipment detail not reported. Noted July 3.

Tex., Dallas—The Theater Electric Light Co., Queen Theater Bldg., is having plans prepared for the construction of a power plant and the installation of one 200 hp. or two 100 hp. generator sets. Estimated cost $50,000. L. G. Bissinger, c/o owner, Engr.

Tex., Lamesa—The Texas Power & Light Co., Interurban Bldg., Dallas, has purchased the plant of the Lamesa Light & Power Co., here, and plans to build a 15 ton ice plant and power plant addition, etc. Estimated cost $50,000.

Tex., Lone Oak—The city, J. E. Rabb, Mayor, will hold an election Dec. 18 to vote $50,000 bonds for the construction of a water and light plant, also sewerage improvements.

Tex., Port Arthur—The Port Arthur Ice & Refrigerating Co. had plans prepared for the construction of an ice plant, 175 ton daily capacity, on Houston St. Estimated cost $300,000. Stone & Webster, 147 Milk St., Boston, Engrs. and Archts.

Tex., San Antonio—The Beacon Hill Ice Co., L. L. Stephenson, c/o Mission Ice Co., 226 Rivas St., Pres., plans to build a 30 ton ice factory on Fredericksburg Rd. and Woodlawn Ave., and is in the market for equipment. Estimated cost $25,000 for building, $75,000 equipment.

Tex., San Antonio—The City Comrs. are receiving bids for a centrifugal pump for swimming pool at Roosevelt Park. D. D. Harrigan, Moore Bldg., Engr.

Va., Altavista—The Altavista Ice Co. is in the market for equipment for proposed ice plant.

Va., Norfolk — The Taylor-Parker Co., Water St. and Commerce Pl., C. A. McLean, Purch. Agt., is in the market for two 250 to 300 hp. water tube boilers, also fuel oil engines, about 40 hp., one from 80 to 100 hp.

Wash., Centralia—The City Council has authorized the installation of auxiliary pumpng and filtration plant, daily capacity 1,500,000 gal. to be increased later to 6,000,000 gal., on the Skookumchuck River. Estimated cost $40,000. N. W. Avery, Engr. Noted Nov. 20.

Wash., Wenatchee—The Wenatchee Cold Storage Co. plans to build a 5 story, 115 x 350 ft. cold storage plant and fruit warehouse on Spring and Wenatchee Sts. Estimated cost $400,000.

W. Va., Junior—The West Virginia Coal & Coke Co., Norton, plans to build a tipple and install coal handling equipment, here. Estimated cost $25,000.

Wis., Monroe—The Blumer Products Co., manufacturer of dairy products, etc., A. Blumer, Purch. Agt., is in the market for ice making machinery, several ton capacity.

Wis., Randolph—J. E. Henzen, Archt., North Main St., Fond du Lac, will soon receive bids for the construction of a cannery, including a 38 x 40 ft. boiler house for the Friesland Canning Co., W. Jones, Pres., here. Estimated cost $75,000. The owner is in the market for conveying machinery, etc.

Ont., Fort William—The Canadian Pacific Ry. Co., Windsor Sta., Montreal, plans to build a hotel, here. Estimated cost $1,000,000. J. M. R. Fairbairn, Ch. Engr.

Ont., Toronto—The Hydro-Electric Power Comn. of Ontario, 190 University Ave., plans to build a 100,000 hp. steam driven electric generating auxiliary power plant. Estimated cost $5,000,000. F. A. Gaby, Ch. Engr. Boilers, turbines, generators and electrical equipment will be installed.

Que., Montreal—The name of the Central Quebec Power Co. is being changed to the Algonquin Power Co., J. Perron, Pres., c/o Perron, Taschereau, Rinfret, Vallee & Genest, Montreal Trust Bldg., 11 Place d'Armes. The capital of the company has been increased from $1,000,000 to $2,000,000. These changes are regarded as preliminary to the formation of plans for the development of a power site.

New Zealand, Wellington — The Secretary, Public Wks. Tenders Bd., will receive bids until Apr. 30, 1924, for Section 2, construction of power house and plant for the Arapuni Electric Power Scheme.

CONTRACTS AWARDED

California—The Yosemite Mountain Club, c/o G. S. Underwood, 609 I. W. Hellman Bldg., Los Angeles, awarded the contract for the construction of club buildings, power house, etc., in the Yosemite Valley to Gutleben Bros., 609 I. W. Hellman Bldg., Los Angeles. Estimated cost $300,000.

Conn., Rockyhill — The Belamose Corp., 983 Main St., Hartford, awarded the contract for the construction of a 1, 2, and 3 story, 199 x 584 ft. factory to D. O'Brien Sons Co., 118 Asylum St., Hartford. Estimated cost $1,000,000. Noted Oct. 2.

Ind., Indianapolis—The Jackson Place Realty Co., 914 Hume-Mansur Bldg., E. G. Spink, Pres., will build a 12 story, 50 x 102 ft. hotel on McCrea St. and Jackson Pl. Equipment detail not reported.

Kan., Kansas City — The city awarded the contract for one 12,500 kva. turbo generating unit and 20,000 surface condensers to the Westinghouse Electric & Mfg. Co., 6th Floor, Orear-Leslie Bldg., $267,400. Noted Nov. 6.

La., Crowley—The city awarded the contract for the installation of water mains, sewer system, concrete reservoir, fire hydrants, pumps, etc., to McIntosh Bros., Oklahoma City, Okla., $198,000. Noted Nov. 13.

Md., Baltimore — The Mayor and City Council awarded Contract 31 for furnishing and delivering two centrifugal pumps for the Highway Engr. Dept. to DeHuff & Hopkin, Morris Bldg., Phila., Pa., $8,980; two 60 hp. motors to Fairbanks, Morse & Co., 115 East Lombard St., Baltimore, $1,810. Noted Nov. 13.

Mo., St. Louis — The Perkinson Realty & Investment Co., 3607 North Broadway, will build a 1 and 2 story, 122 x 227 ft. ice plant on Penrose St. by day labor. Estimated cost $175,000. Polar Wave Ice & Fuel Co., 3626 Olive St., lessee.

Neb., Omaha—The Nebraska Power Co., 15th and Farnam Sts., J. T. Davidson, Genl. Mgr., will build a 3 story power plant by day labor. Estimated cost $700,000.

N. Y., Cohoes—The Mohawk Paper Makers, Inc., awarded the contract for the construction of a 1 story, 46 x 90 ft. power house to generate 750 hp. to T. Neary, Cohoes; equipment, including 700 kva. generator switchboard, etc., to the Genl. Electric Co., River Rd., Schenectady. Estimated cost $95,000.

N. Y., Long Island City — The city awarded the contract for reconstruction of pumping station in Camp Rd., etc., to J. Gallo, 203 Division St., Brooklyn, $36,987.

N. Y., New York—A. D. Antona, c/o R. Candela, Engr. and Archt., 200 West 72nd St., will build an apartment house on 5th Ave. and 11th St. by day labor. Estimated cost $1,000,000. Equipment detail not reported.

N. Y., New York — The Eight Hundred Seventy West End Ave. Corp., c/o R. Candela, Engr. and Archt., 200 West 72nd St., will build an apartment house on West End Ave. by day labor. Estimated cost $1,000,000. Equipment detail not reported.

N. Y., New York—The Turner Constr. Co., 244 Madison Ave., will build a 9 story, 100 x 110 ft. apartment house at 49-55 East 66th St. Estimated cost $1,000,000. Equipment detail not reported.

Pa., Rook (Pittsburgh P. O.)—The Pittsburgh & West Virginia Ry., Wabash Bldg., Ptitsburgh, awarded the contract for the construction of a 1 and 2 story, 50 x 100 ft. power plant, here, to the Dresser Minton Co., 880 Arcade Bldg., Cleveland, Ohio. Noted Nov. 13.

Tenn., Memphis—The Electric Ice & Coal Co., c/o E. M. Lowrance, Falls Bldg., awarded the contract for the construction of an ice plant at 430 North Waldran St. to R. B. Howell, Memphis. Estimated cost $40,000.

Tex., Dallas—E. F. Hamilton, 726 North Beacon St., awarded the contract for the construction of an 8 story, 275 x 400 ft. apartment hotel on Oak Lawn and Cedar Springs St. to the Gilsonite Constr. Co., South West Life Bldg., Dallas. Estimated cost $1,800,000. Equipment detail not reported.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

Declines—Leather belting discounts increased. Raw linseed oil down 3c. in New York and 5c. per gal. in Cleveland, during month; heavy drop in Chicago. Minimum on structural rivets down 10c.; boiler rivets, 25c. per 100 lb. at Pittsburgh mill. Cold drawn steel declined 25c. per 100 lb. in New York and Chicago warehouses.

Advances—Pipe and boiler covering discounts lower. Cotton waste higher in Chicago. Babbitt metal up 3c. to 4c. per lb. in Chicago; advances ranging from ½c. to 16c. per lb. reported on all grades in Cleveland.

No change in prices of electrical supplies.

POWER-PLANT SUPPLIES

HOSE—

Fire	50-Ft. Lengths
Underwriters' 2½-in., coupled	51½c. per ft.
Common, 2½-in., 3-ply	$1.00 per ft. list less 40–10–5%

Air—Best grade

¼-in., per ft.	3-ply $0.33	4 ply $0.42

Steam—Discounts from List

First grade 40–5%	Second grade 45%	Third grade 50%

RUBBER BELTING—The following discounts from list apply to transmission rubber and duck belting:

Competition 60–5%	Best grade 50–10–5%

LEATHER BELTING—List price, 2c. per sq. in., per ply.

Grade	Discount from list
Medium	40–2½%
Heavy	30–5%

RAWHIDE LACING { For cut, best grade, 45–5%, 2nd grade, 55%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 45–5%; sides, 41c. per sq.ft.

PACKING—Prices per pound:

Rubber and duck for low-pressure steam, ⅛ in	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.70
Duc. and rubber for piston packing	.90
Flax, regular	1.10
Flax, waterproofed	1.70
Compressed asbestos sheet	.80
Wire insertion asbestos sheet	1.30
Rubber sheet	.45
Rubber sheet, wire insertion	.70
Rubber sheet, duck insertion	.50
Rubber sheet, cloth insertion	.25
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.30
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		45@50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.55@$2.65 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.64 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York Current	Cleveland	Chicago
White	10.00@13.00	15.00	14.00
Colored	8.00@13.00	12.00	10.50

WIPING CLOTHS—Jobbers' prices, in cents per lb., as follows:

	13¼ x 13¼	13¼ x 20¼
Chicago	16.00	16.00
New York	9.00	
Cleveland	$36.00 per M.	$52.00 per M.

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.95	$1.00	$0.94

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	14.00	12.75	15.50	14.25
White	14.00	12.75	14.00	12.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

	New York	Cleveland	Chicago
Steel ⅞ and smaller	50%	60%	60%
Tinned	50%	60%	4½c. per lb. net

Structural rivets, ½ - ¾ in. diameter by 2 in. to 5 in. sell as follows per 100 lb.

New York $4.40	Chicago $3.75	Pittsburgh $2.65@2.85

Boiler rivets, same sizes:

New York $4.50	Chicago $3.85	Pittsburgh $2.85@3.00

REFRACTORIES—Prices in carlots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$50@55
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	26@31
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	30@35
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	42.00@43.50
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	41@48
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	42@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	42@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	36@43
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	37@39
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	37@39
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Warehouse prices in cents per pound:

	New York	Cleveland	Chicago
(83% tin)	52.00	68.00	48@52
(35% tin)	25.00	18.00	22@25

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.40	$3.90	$4.30
Flats, square and hexagons, per 100 lb. base	4.90	4.40	4.80

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%
Pressed steel boiler hangers	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots on the latest Pittsburgh basing card:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	¾ to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½ to 4	26	11
7 and 8	56	43½	4½ to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	¾ to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
4	.....	.....	$0.23
1¼	.....	.....	.25
1½	.....	.....	.22
1¾	$0.26	$0.29	.23
1	.20	.25	.21
1¼	.23	.29	.23
1½	.24	.33	.28
2¼	.....	.....	.....
2	.30	.41	.32
2¼	.32	.47	.35
3¼	.34	.51	.37
2	.43	.64	.47

Tubes 2¼ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per lineal foot based on stock lengths. If cut to special engths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

1¼ in. to 2 in. diameter, 5c. per cut. 2¾ in. diameter, 7c. per cut
2½ in. diameter, 6c. per cut. 3 in. diameter, 9c. per cut
3½ in. to 4 in. diameter, 10c.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$ 46.00 (net)	$ 81.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	30%	15%
Coils to 1,000 ft.	40%	20%
1,000 to 5,000 ft.	45%	25%
5,000 ft. and over	45–5%	25–5%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
½	$61.10	$66.16	$9.90	$11.03	$5.74	$6.16
¾	79.20	84.95	13.00	14.49	8.18	8.78
1	112.06	122.19	19.26	21.46	10.65	11.42
1¼	151.62	165.31	25.65	28.33	14.76	15.78
1½	181.28	197.67	34.19	37.77	18.23	19.47
2	248.90	265.94	62.70	69.24	24.29	25.97
2½	385.50	420.48	102.58	11.33	34.71	37.10
3	504.29	548.81	273.40	302.12	51.66	55.63
3½	633.86	688.65	604.03	667.15	69.41	74.19
4	772.62	838.59	697.06	770.99	86.76	92.73

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG

S. P. M. L.	$0.10	D. P. D. B.	$0.32
D. P. M. L.	.16	T. P. S. B.	.30
T. P. M. L.	.24	T. P. D. B.	.42
D. P. S. B.	.18		

CUT-OUTS, N. E. C. FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.75	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.90	.....
T. P. S. B.	.65	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.15	3.00	.....
T. P. to D. P. D. B.	.80	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy	$23.00
No. 16 cotton reinforced heavy	29.00
No. 18 cotton reinforced light	19.50
No. 16 cotton reinforced light	22.50
No. 18 cotton Canvasite cord	17.00
No. 16 cotton Canvasite cord	19.25

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.20	3-amp. to 30-amp.,	100	$0.40
35-amp. to 60-amp.,	100	30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less 1-5th standard package, 55%; 1-5th to standard package, 60%; standard package, 65%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500)	$2.70
0–30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities:

Straight-Side Bulbs Mazda B— Watts	Plain	Frosted	No. in Package	Pear-Shaped Bulbs or Bowl Enameled Mazda C— Watts	Clear	Frosted	No. in Package
10	$0.32	$0.37	120	75	$0 55	$0.60	60
15	.32	.37	120	100	.70	.75	24
25	.32	.37	120	150	.90	.95	24
40	.32	.37	120	200	1.15	1.25	24
50	.32	.37	120	300	1.75	1.85	24
60	.37	.42	120				
				500	2.50	2.65	12
				750	3.75	4.00	8
				1.000	4.25	4.50	8

Standard quantities are subject to discount of 10% from list. Annual contracts ranging from $150 to $300,000 net allow a discount of 17 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.19
Composition 2-piece attachment plug	.29
Swivel attachment plug	.12

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York.

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$ 6.80	$ 9.27	$10.75	$17.20
12	9.50	11.79	13.40	23.40
10	12.70	15.50	17.20	29.00
8	17.50	19.80	22.87	38.00
6	.....	.....	32.00	.....
4	.....	.....	43.75	.....
2	.....	.....	64.00	.....
1	.....	.....	85.50	.....
0	.....	.....	109.00	.....
00	.....	.....	132.00	.....
000	.....	.....	159.00	.....
0000	.....	.....	189.00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each	Keyless Each	Pull Each	⅜ In. Cap Key Each	Keyless Each	Pull Each
$0.33	$0.30	$0.55	$0.39	$0.36	$0.61

Less 1-5th standard package	25%
1-5th to standard package	32%
Standard package	37%

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lc	33c lb.
Rubber tape, ¾ in., less 100 lb. 34c. lb., 100 lb. lots	33c lb.
Wire solder, less 100 lb. 27c. lb., 100 lb. lots	29c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%